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The Factories Bill

As we forecast when dealing with the last Report of the Chief Inspector of Factories, very great changes in the law affecting factories and workshops are proposed in the Factories Bill, which is about to be considered by the House of Commons and will doubtless be passed very much in its present form. No less than five and a-half million persons will be affected by the measure, which is both a codification and an extension of the existing law. One provision, which makes for greater simplicity, abolishes the present distinction between a factory and a workshop. In fact, for many purposes the word "workshop" will disappear; thus what used to be known as "men's workshops," because no overcrowding restrictions were applied, now cease to exist. Roughly speaking, the Bill seeks to make universal the rules that are already observed in the best factories. For a limited period buildings and methods that are no longer satisfactory will be allowed to continue, but all new factories must conform to the new standard.

Naturally, the main object of the Bill is to secure for the factory worker better conditions of health, safety and comfort; in some cases rules designed to protect women and young persons will be extended to men. One omission from the Bill is itself a testimony to the advance made in recent years; children are not mentioned, because there is none working in factories. Overtime is still permitted for workers over sixteen, but under severe restrictions. Thus, a factory employing women and young persons may work in the aggregate 100 overtime hours in a year, but not more than 6 hours in any week. Power, however, is given to the Home Secretary to extend the periods in special cases, such as arise in the foundry industry, when liquid metal has been melted and the moulds have not all been cast up. Again, where a casting has been made and requires several hours' feeding, or parts of the casting require baring to obviate casting stresses being set up. Apparently, the overtime rule must also limit the hours during which men may work. Another distinction which disappears is that between textile and non-textile factories; at present the limit for women is 55½ hrs. a week in the first and 60 in the second. For these limits the Bill substitutes a 48-hr. week and a 9-hr. day. Apparently the word "overtime" applies to the factory rather than to the worker, so that a factory may be working overtime although very few employees remain beyond the normal hours. Some elasticity is provided by a provision that different parts of a factory or different sets of persons in different processes may be regarded as working in different factories.

The new Bill provides that all young persons under 16 will require a certificate of fitness. Among other provisions designed to ensure the health of workers is the requirement that factories must be sufficiently and suitably lighted. Another interesting clause says that makers of machinery are to be held responsible if they supply any machine that does not conform to the standard of safety laid down in the Bill. While the new obligations and restrictions apply, naturally enough, to the employer, there are some which apply to the worker. Thus, one clause forbids workpeople to interfere with safety, health, or welfare appliances, and makes their use obligatory. The Bill conforms to the modern tendency in legislation, *i.e.*, it aims at raising the practice of the indifferent factory to the level of the good factory. It will, of course, involve an increase in the number of factory inspectors and in the clerical staff of the Home Office.

There is sure to be some outcry against the extra cost involved in complying with the health and safety-first provisions, but we are satisfied in our own minds that most innovations of this character are actually profit-making. Modern lavatory accommodation is less costly in upkeep—plumbing as well as normal cleaning—whilst one of the provisions of the Bill which enacts that manufacturers of machinery will deliver their goods to the foundries in a fool-proof working order, will have the general approbation of the users. Many accidents take place during the "teething" stage of a new plant, often whilst the various guards are actually in order. We are unaware as to whether lighting conditions of factories, except in general terms, are to be laid down, but here again, those foundries which have followed the advice of experts are satisfied that such an action is of a profitable character. Much the same can be said of heating and ventilation. Some trades, not foundry practice, will certainly be troubled in the initial stages of proper illumination, as the older craftsmen will be unable to judge temperatures correctly. It is a well-timed Bill, for industrial conditions are at present so healthy that any increased expenditure necessitated can in most cases be absorbed without great difficulty, though we admit in certain cases they will involve hardships for some of the smaller establishments.

The Cast-Iron Hollow-Ware Industry*

BEGINNINGS IN BIRMINGHAM AND WEST BROMWICH

By J. I.

"All the great manufacturers I have ever known, have begun the world with very little capitals," Matthew Boulton said. John Izon and Thomas Whitehurst, who founded and built up from primitive beginnings the cast-iron hollow-ware industry of West Bromwich, were among those he must have known more intimately.

In 1763 Izon was established in Coleshill Street —"in the Parish of Aston near Birmingham"— as a brassfounder. He employed no more than six or eight hands and worked with a capital of £100 or less. Hutton described the trade as "less ancient than profitable"; but even after the new canal was cut in 1769, reducing coal to half its original cost, it was still a trade carried on at a disadvantage. The Birmingham brassfounder was handicapped by lack of water power and difficulties of transport, and since a powerful combine at Bristol monopolised the manufacture of the raw material, prices were arbitrarily raised against customers. To counteract these high-handed methods, the more energetic founders began to work in iron as well as brass, and among these Izon and his new partner Whitehurst were rapidly developing a growing trade in cast ironmongery.

In 1775 "by Application and Study, and at a considerable Expence" Izon invented "a New Method of Casting all sorts of Hinges, ready jointed, in Cast Iron." This invention he claimed "would be of Great Benefit to the Publick in General." The firm took out a patent in December. On January 8, 1776, an advertisement appeared in "Aris's Birmingham Gazette"—"By His Majesty's Patent, granted unto Izon and Whitehurst of Birmingham, for Casting of Butt, and other Sorts of Hinges of Cast Iron, ready joined, equal to those made of Wrought Iron. Merchants and Ironmongers may be supplied at their Manufactory, Coleshill Street, Birmingham." The new cast hinges could be made and sold at a cheaper rate than "those compos'd of Hammered Iron," and as they found a ready market the firm began to prosper.

Removal to West Bromwich

More important developments followed. In 1779, Jonathan Taylor took out a patent for casting and tinning oval-bellied cast-iron pots. Taylor, employed as "founder" at the Eagle Foundry in Broad Street, offered to sell his patent to Izon and Whitehurst. They were quick to grasp its possibilities, and in a few months their output so increased that reorganisation of the works became an immediate necessity. Conditions at the Coleshill Street foundry were primitive. Owing to lack of water power, the mill had to be turned by a horse, and the blast for melting the iron raised by a large hand-worked bellows.

They decided to move the works away from the town, within reach of an adequate water supply. A lease was therefore taken of the Mill on the Tame at West Bromwich from the Turtons, who had worked it since the sixteenth century. It would be difficult to imagine a better site. The coalfields of Wednesbury—"the best in the Kingdom" wrote a contemporary—were only two miles away, the new canal and the stream to turn the mill were within a stone's throw. The district was undeveloped; a straggling line of houses stretched from the church south to the great turn-pike road, but the rest was open common, surrounded by "a rich and pleasant valley" of woods and corn-fields. There is a tradition that when Izon tried to find lodgings for his handful of men in the village, the villagers were so hostile and suspicious that they refused to take them in, and cottages had to be bought or new ones built. Here, in the autumn of 1780, the first cast-iron hollow-ware foundry was established.

The senior partner and his sons controlled the works, prominently marked on a local map of 1788 as "Izon's Foundry." An early print shows the various shops of smith and founder, the furnaces, drying-kilns and sheds, the main building with bell-tower and clock, all dwarfed by the chimneys of Watt's new steam-engines. Steam-driven cranes fed the wharfs alongside the canal, where barges unloaded coal from the neighbouring collieries, or carried the finished goods along a network of the new waterways to Bristol, Liverpool and Hull. "Articles of every description in Cast Iron" left the foundry for the home market or to be shipped overseas. After 1795, Boulton and Watt built their own foundry at Soho, but in 1800 they still placed orders for small engine parts "to be cast at Izon's." Other foundries were established in the neighbourhood, among them Archibald Kenrick's in 1793, but for a long time Izon and Whitehurst had the monopoly of the hollow-ware trade.

Overseas Trade through London

The firm's first London warehouse was opened in 1777 in Huggin Court, off Thames Street, by Whitehurst. It was small and inconvenient, and two years later he took a larger premises at 16, St. Martin's-le-Grand, behind St. Paul's Churchyard. Only a few years before, not a single Birmingham merchant had had direct dealings with firms abroad, and goods used to be exported through London houses. With the rapid increase of trade after the purchase of Taylor's patent, still larger premises were taken on Queenhithe in Thames Street. This famous street was then, as to-day, "one of the most incommodious in London, being perpetually incumber'd with carts, driving to and from the wharfs on the Thames side, and so wet and dirty, that no Man wou'd pass thro' it, if his Business did not oblige him." Here for the next fifty years the firm plied a remarkable overseas trade, and built up a high reputation in the City. It is interesting to recall that Whitehurst, living at this time (1785-1805) in his pleasant house at Islington, walked or rode to his offices every day across the fields.

In the old print of the West Bromwich works, the iron-master's house stands near the workshops, but fenced in like a country villa by hedge and trees. An old sale bill describes the more substantial house where he retired as "a Pleasant Country Residence" with "Barns, Stables, Cow-sheds, and fifty-seven Acres of Arable and Pasture Adjoining." In a society predominently rural, the industrial pioneer built his barns and mills side by side.

When he died in 1814, the forces he had helped to shape were already making a new social order. The population of West Bromwich more than trebled itself; chimneys tapered "to a height rivalling the London Monument," and on land lately an open common, streets and houses grew in the night. "An overgrown village, blacken'd with its trees, and hedges, by the forge fires," observed a traveller in 1792. At the more radical changes of the next half-century nobody would have been more astonished than the iron-master himself.

* Reproduced, by permission, from the "Birmingham Post."

Book Review

Mechanical World Year Book, 1937. Manchester: Emmott & Company, Limited, 31, King's Street West. (Price, 1s. 6d. net.)

The fiftieth annual publication of the "Mechanical World Year Book," apart from being revised throughout to cover the most recent advances in practice, also includes an entirely new article on the design and manufacture of toothed gearing, by W. A. Tuplin, M.Sc. This article, which has 11 tables, covers 31 pages. The other well-known features of the Year Book have been preserved and brought up to date.

Random Shots

In view of the fact that the London Branch of the I.B.F. has planned a visit to Belgium in the near future (sahibs only; wives, please note), and that the International Congress is this year taking place in Paris, "Marksman" feels that there is room for yet another committee. This Languages Committee would publish a specialised phrase-book, beginning with French, for use by foundrymen when taking part in International Congresses and the like. It would bear in mind that more than a few foundry visitors to "furrin parts" will have forgotten practically everything they learnt at Heton and 'Arrow, and that those with long memories will find that they will not need to borrow the pen of their aunts, but rather the quids of their pals.

* * *

The first phrase, of course, would be "ôn est Mr. Makemson, s'il vous plait?" for the men, or, alternatively, for wives, "Avez vous vu mon mari?" "J' ai perdu mon carnet," "L'autobus est une demi-heure en retard." "Voulez vous me dire la direction pour le Folies Bergères" should be granted a place, and all foundrymen wish to know how to count up to ten, at the least, because they frequently suffer from great thirst.

* * *

Of course, there must be a small section for technical words, just to show that participants do really set out with an idea of taking business seriously. The committee should include such names as Stobie, Delport, Kent, Wharton and Faulkner, all of whom talk French like Dutch natives, with Mrs. Roy Stubbs co-opted to render assistance to visitors to foundries in North Belgium.

* * *

Next year the International Congress takes place in Poland, and "Marksman" knows of nobody in the foundry industry with a knowledge of Polish, and he suggests a prize for the collector of the largest number of words during next year's visit. They should be correctly spelt with the right proportion of consonants to vowels per word. The words "ladies," "gentlemen," and "beer" will not be counted, because all visitors to a foreign country should learn those before they go. Madame Gierdziejeweski might be invited to come to England to be the judge. More than one foundryman would welcome the opportunity to entertain so charming a lady, whose English is as sweet to hear as she is to behold.

* * *

There has been much putting together of heads and running to and fro to libraries and museums to determine the date of the earliest known casting. It seems to be an established fact that ancient China has forgotten more about castings than the modern world has ever known.

It seems that yet another antique has been unearthed in Wuhu, in Huhwei province, China. This is an ancient brass tomb containing brass candle tables and basins, and the period is believed to be A.D. 214—589.

But why go so far as China? "Marksman" wonders whether in some of our English inns there could not be found a bath which could claim great antiquity as a casting?

* * *

London offers unique opportunities for the tired-limbed and weary-souled business man to slip away for a few minutes and rest in its many city churches. The sense of sudden quiet and peace is both remarkable and extraordinarily soothing—and it is amazing what interest there lies, for the foundryman, so unassuming, within their doors. In one tiny church off the Strand, "Marksman" found a very beautiful lectern with enamelling decoration that is a delight to the eye; and another beautiful casting in bronze. In the city he found an ornamental cast lead chest, obviously of great antiquity.

"MARKSMAN."

Temperature Gradients in Furnace Walls

PROPER SELECTION OF HEAT INSULATION

Before a meeting of the Institute of Fuel, held in London on February 10, Mr. J. S. F. Gard, B.Sc., A.I.C. read a Paper on "Heat Insulation: The Selection of Suitable Materials for Various Purposes," from which we give the following extracts dealing with high-temperature plants.

In dealing with the insulation of high-temperature furnaces it is necessary closely to consider the temperature gradients through the walls in relation to the softening temperature of the refractory. Considering a case where the internal temperature is approaching the softening point of the refractory, with no insulation this

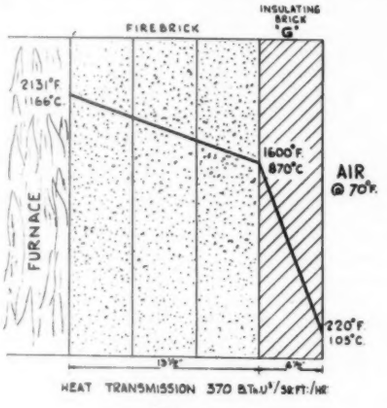


FIG. 1.

will only take effect through a small thickness of the firebrick, since the temperature gradient is steep owing to the relatively high conductivity. When, however, the refractory is backed by insulation the temperature gradient becomes much less steep and the whole thickness of the firebrick lining is raised to a temperature more nearly approaching that of the inside face. Hence the softening effect spreads through a greater thickness of the brick.

Then it is advisable to employ a higher grade refractory. Consideration, therefore, should be given to the refractory and the insulator as a whole, although their respective functions are independent. For example, a high-grade refrac-

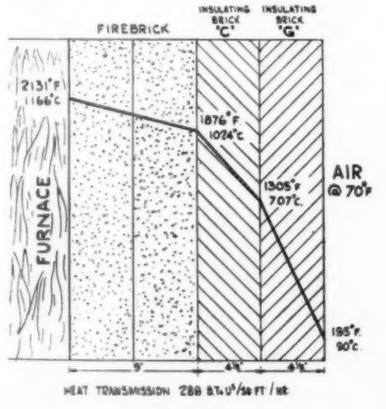


FIG. 2.

tory plus an insulating course will usually result in a higher thermal efficiency than a greater thickness of low-grade refractory without insulation. When the problem is dealt with in this way the insulation has the added advantage of preserving the refractory and increasing its life; the more even temperature of the whole mass lessens the strains and tends to prevent spalling.

It is, unfortunately, an established fact that as refractoriness and mechanical strength in insulating bricks increases, the efficiency falls; thus it is necessary, when very high temperatures are being dealt with, to employ more than one grade of insulating brick to obtain the greater efficiency. Figs. 1, 2, 3, and 4 show the temperature gradients through various combinations of refractory and insulating bricks.

The method of arriving at the several interface temperatures in order to determine the grades to use and the thicknesses is one of trial and error and can be easily done if the several thermal conductivities and the limiting temperatures are known in conjunction with a surface

TABLE I.—*Properties and Certain Qualities of Firebrick.*

Brick no.	Density, lbs. per cub. ft.	Limiting temp., deg. Fah.	Crushing force, lbs. per sq. in.
A	92.3	3,000	Over 700
B	73.5	2,000	600
C	41.0	2,200	400
D	40.5	2,000	500
E	38.8	1,700	350
F	37.1	1,650	150
G	33.0	1,620	195
H	35.2	1,800	245
I	32.0	1,600	250 and 100

temperature/heat loss curve. Table II gives the heat loss over a range of surface temperatures for a normal vertical wall surface situated in still air at 70 deg. Fah. This can be plotted graphically for convenience in general use.

The author then went on to give a typical calculation by way of example. It is proposed to build an insulated furnace to work at 2,000 deg. Fah. internal temperature, using 9 in. of refractory as a lining, with a steel-plate casing on the outside and 9 in. of insulation giving the most efficient combination of insulating bricks

TABLE II.—*Heat Loss over a range of Surface-Temperatures.*

Surface temp., deg. Fah.	Heat loss in B.T.U. per sq. ft. per hr.
100	48
150	152
200	280
250	436
300	618
350	825
400	1,070
450	1,360
500	1,680
550	2,050
600	2,470
650	2,940
700	3,480
750	4,050

C and G (Table I). It is also desired to know the outer surface temperature and the heat transmission through the wall.

Consider the vertical wall in calm atmosphere at 70 deg. Fah. As we have two unknown quantities we proceed by the trial and error method and first of all we must assume a likely value for the outer surface temperature, which can be done with reasonable accuracy after some practice. Now let us see whether the 9 in. of insulation can be made up entirely of the more efficient brick G.

T_1 (internal temperature) .. .. = 2,000 deg. Fah.
T_2 (interface temperature) .. .. = Unknown.
T_3 (outer surface temperature) .. = assumed 200 deg. Fah. for a first trial.

From standard data and manufacturer's tables one finds under the stated conditions

k_1 (the conductivity of the firebrick) = 9.91
k_2 (the conductivity of brick G) = 1.22

Hence the average conductivity for the wall—

$$k = \frac{18}{\frac{9}{9.91} + \frac{9}{1.22}} = 2.17$$

Then H the heat transmission in B.T.U. per sq. ft. per hr.

$$= \frac{k(T_1 - T_3)}{L} = \frac{2.17 \times 1800}{18} = 217 \text{ B.T.U.}$$

In a graphic representation of Table II we find T_2 corresponding to a heat loss of 217 B.T.U. per sq. ft. per hour to be 176 deg. Fah. Hence the

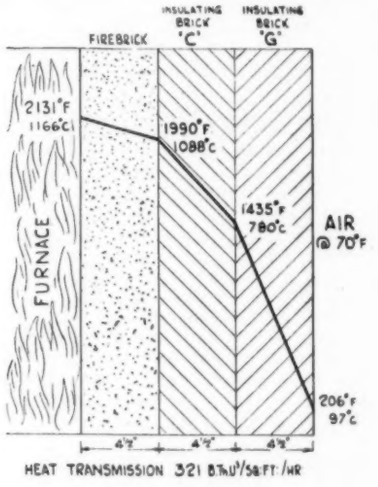


FIG. 3.

assumed surface temperature was too high and we must make another trial. Substituting the value of 180 deg. Fah. for T_2 we get H = 219.4 B.T.U. We now must find whether the temperature at the interface of the firebrick and brick G is above the limit of 1,625 deg. Fah. given for it. The heat flow through both sections of the wall is the same—namely, 219.4 B.T.U., and so we have only one unknown value, T_2. Equating we get

$$\frac{9.91\,(200 - T_2)}{18} = \frac{1.22\,(T_2 - 180)}{18}$$

whence T_2 = 1,800 deg. Fah., which is too high. Thus it will be necessary to interpolate

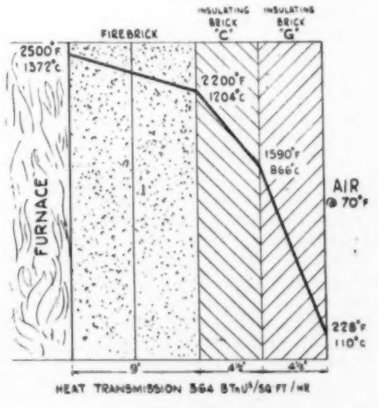


FIG. 4.

a course of brick C which will withstand a temperature of 2,200 deg. Fah. between the firebrick and the G brick. By a similar procedure we find that a suitable construction is:—9-in. firebrick, 3-in. brick "C," 6-in. brick "G," that the heat transmission will be 254.4

B.T.U. sq. ft./hr., the two interface temperatures 1,770 deg. Fah. and 1,451 deg. Fah. respectively, and the outer surface temperature 190 deg. Fah.

To some extent the loss of heat from a kiln or furnace can be reduced by increasing the thickness of refractory. Thus at a furnace temperature of 2,200 deg. Fah. the heat transmission through various thicknesses of normal refractory, in B.T.U. per sq. ft., is:—4½ in., 3,045 (T_s = 650 deg. Fah.); 9 in., 1,637 (T_s = 494 deg. Fah.); 13½ in., 1,132 (T_s = 410 deg. Fah.); 18 in., 869 (T_s = 360 deg. Fah.); 27 in., 594 (T_s = 295 deg. Fah.); and through 9 in. of refractory plus 4½ in. insulating brick G is 427 B.T.U. (T_s = 248 deg. Fah.). It is obvious that from the point of view of economy of floor space it is not good practice to build thick walls, but there is another factor which plays an important part, especially in intermittent heatings, and that is the heat-storage capacity of the structure.

Refractories have a specific heat of about 0.3 at 1,000 deg. C., and by calculation it can be shown that to raise the temperature of a structure consisting of 10,000 bricks to an average temperature of 930 deg. Fah. would require about one ton of coal; all of this heat is lost during the cooling period. Even allowing that the insulating bricks have the same heat storage capacity as refractories per unit weight, the saving in this way is very considerable. In addition the heating-up period is greatly reduced, the temperature in the furnace is more evenly distributed with greater ease, the load is better and more evenly burnt, and the proportion of the spoilt products by overheating at the top or underheating at the bottom reduced to negligible proportions.

From what has been said regarding the thermal insulation of furnaces it will be seen that the "long-felt want" in this direction is a combination of insulating and refractory properties, with as much mechanical strength as possible in one and the same brick. A considerable amount of work has already been carried out with this end in view both in this country and in America, with some degree of success; but development is still in its infancy. The problem, as can be imagined, is not an easy one, and its solution can only be a compromise between the several desirable factors, since for a good refractory a close texture is usually deemed necessary, whereas a close texture in high-temperature-resisting materials gives high density; thermal conductivity, on the other hand, is more or less proportional to density. It has been found, however, that at the higher temperatures size and configuration of pores also play an important role in conductivity.

This class of brick has both advantages and disadvantages. For intermittent work its low heat capacity is a distinct asset as it enables quick raising of temperature; it also, of course, has most of the advantages of the bricks already considered. On the other hand, however, it cannot be used for furnace linings where a fusible ash (such as might occur in the use of pulverised fuel) or slag is developed; these would be too readily absorbed by the porous brick with consequent failure. Its structure too, renders it very susceptible to abrasive action. The author's personal opinion is that it is always advisable to use a high grade of refractory for the actual furnace lining and that the function of insulator is quite distinct. The more refractory the insulator, of course, the less true refractory lining is required and the greater the space available for insulation.

AN EXTRAORDINARY MEETING of Head Wrightson & Company, Limited, has been called for March 1, to consider a resolution that the capital be increased to £630,000 by the creation of 210,000 ordinary shares of £1, ranking for dividend and in all other respects *pari passu* with the existing ordinary shares.

Annual Dinner of Lancashire Foundrymen

Mr. J. Hogg, Branch-President, presided at the annual dinner of the Lancashire Branch of the Institute of British Foundrymen, which was held on February 6, at the Grand Hotel, Manchester.

PROFESSOR F. C. THOMPSON, President of the Manchester Metallurgical Society, in proposing the toast of the Institute of British Foundrymen, and the Lancashire Branch, said he was paying no empty compliment when he said that to propose that toast was a real pleasure. Whether they liked it or not, the technical characteristic of the present era was the change from the craftsman to the scientifically controlled organisation and transitions of that kind were invariably difficult. To the onlooker, one of the most outstanding features of the changes which were taking place was the quiet and calm manner in which they were being effected. It was perhaps suitable that someone connected with higher metallurgical education should propose that toast. The work which the Institute of British Foundrymen was doing towards the higher metallurgical education of members of the industry with which it was connected was well known, but he could assure them that the most interesting educational experiment which was being tried out in the University of Sheffield—an experiment for which members of the Institute were largely responsible—was being watched with the very greatest interest by all concerned with higher technical education. It was a pleasure to couple the Lancashire Branch with the toast.

MR. H. WINTERTON, President of the Institute, responding, said, as they all knew, the Lancashire Branch was the first Branch of the Institute, being formed in 1905, immediately after the formation of the parent body. During the time it had been established, the Branch had shown very steady growth, and to-day the number of members was about 370 out of a total membership of 2,000. About half of those were Associate Members, and now that the Institute was taking a definite and special step, he hoped many of the Associate Members in the Institute would seriously consider the advisability of advancing their membership and becoming Members. By that means they would be assisting in the upward trend which their Council hoped might be taken in the very near future.

He would like to congratulate the Burnley Section upon its prosperity. A great deal of credit and honour for establishing and maintaining the Burnley Section was due to their present President, Mr. Jos. Hogg, who had been ably assisted by Mr. J. Pell, secretary of the Section for 14 years. He understood it was established in order that the members who were unable to get to Manchester would be able to take an active part in the work of the Institute, and he commended that method to other districts with the same difficulty to overcome. The Branch operated another section at Preston, and they had a successful Junior Section in Manchester, at present presided over by Mr. J. E. Cooke.

Lancashire had already organised five conferences, and it would not be very long, he supposed, before Manchester once more welcomed its local President, and instituted him as President of the Institute.

They were sorry that two of the old members, Mr. W. H. Sherburn and Mr. R. W. Kenyon, had not been able to be with them that evening, but he had had a very interesting letter from Mr. Kenyon at Christmas, in which he expressed his extreme delight with the Institute's notable progress, and wished them success in the future. There were other members he would like to name if time would permit—Mr. Miles, who had worked so hard for the Lancashire Branch, Mr. Meadowcroft, Mr. W. N. Cook, Mr. Phillips, Mr. Flowers, Mr. J. Jackson, all of whom were Past-Presidents of the Lancashire Branch, and all of whom had, in their time, done really fine work for the Institute. As to their present President, Mr. Hogg represented a very old-established firm of great repute, and all who knew him would say that he did his duty equally well to everyone. He had been very energetic for many years on behalf of the Lancashire Branch, and he sincerely trusted that he might carry on the good work in which he was at present engaged for many years. They had the honour of having as a private member their general secretary, and he was sure that no Institute in the British Isles or any other country in the world had a more energetic or capable secretary than their own secretary, Mr. Makemson.

MR. R. A. JONES, Senior Vice-President of the Branch, proposed the health of the visitors and guests in felicitous terms.

MR. C. W. BIGG (Senior Vice-President of the Institute), in responding, said it indicated progress that such functions should be held, for at one time the foundryman would not have thought seriously about attending such a gathering, much less would have thought of organising it. It might be thought that the harsh and unpleasant features which were prominent and essential parts of their industry, would never altogether be eliminated, but he would suggest the present preponderence of those unpleasant features should be regarded as something which did not represent finality. Professor Thompson had indicated that they were in a state of transition from the craftsman to the scientific control of the industry. Science was showing to foundrymen that there was much more in casting than just putting metal into a mould. Artistic and social progress were showing them that there was very much more in life than just work and sleep; the sand, the smoke, and the sweat might be more or less prominent and permanent phases in their foundries, but let them as members of the Institute so strive to ensure the introduction and use in their industry of all that was best in science, in art and in social progress, so that the unpleasant side of their business could be, if not altogether eliminated, considerably ameliorated.

MR. J. HOGG, Branch-President, extended a warm welcome to the guests, and hoped they might join them again in these social functions where they met so happily together.

MR. H. WINTERTON presented the Diploma of the Institute to Mr. A. Phillips, of Manchester, the diploma having been awarded in recognition of the excellence of his Paper, "Some Points in Modern Production of Castings," read before the Burnley Section of the Lancashire Branch. Mr. Phillips briefly responded.

Water Pollution Research

The Department of Scientific and Industrial Research has issued No. 1 of volume X of the "Summary of Current Literature," relating to water pollution research. The issue contains 114 abstracts of recent Papers dealing with water supplies, the analysis and examination of water, sewage, trade-waste waters, the pollution of natural waters and miscellaneous subjects. These Summaries are published by H.M. Stationery Office, Adastral House, Kingsway, W.C.2. (Price 2s. net each, or annual subscription of 24s. net, post free.)

Accidents and Industrial Diseases

In the course of a lecture on "Accidents and Industrial Diseases in Factories" given at the Wolverhampton and Staffordshire Technical College recently. Mr. H. W. Atkinson, H.M. Inspector of Factories, said that speed of production was responsible for more accidents in factories than fatigue. Sand-blasting, he said, was one of the most dangerous trades as far as the operator was concerned. Statistics showed that 5.4 per cent. of the men engaged in the industry died from silicosis, or silicosis with tuberculosis, and the average duration of employment of sand-blasters who died from silicosis was 10.3 years, as compared with 40.1 years for all occupations. Mr. Atkinson advocated the use of steel grit instead of sand for cleaning purposes, and he said that employers were gradually adopting it.

Cast Iron and Its Applications in Engineering*

By A. CAMPION

Cast iron is widely used in engineering and allied industries because, in comparison with other ferrous materials, it possesses important advantages. It can be easily cast into intricate shapes without serious porosity or shrinkage, it is easily machined and can be produced at low cost with a wide range of physical properties, although the attainable properties are not

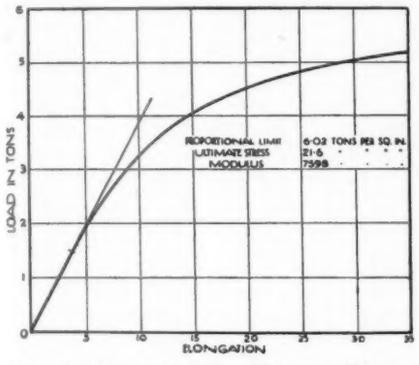


FIG. 1.—MEEHANITE B. MODULUS TENSION TEST AT 15 DEG. C.

generally appreciated and are frequently subordinated to low cost with a conscious or unconscious sacrifice of utility. This is due in large measure to an incomplete understanding on the part of the engineer, of the properties possessed by modern cast-iron types of material, and sometimes to a lack of proper methods of testing.

The casting process lends itself to the formation of intricate integral parts with a strength and rigidity obtainable frequently by no other method of manufacture. The field for cast parts

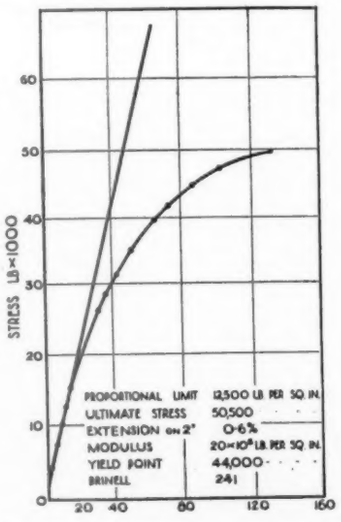


FIG. 3.—MEEHANITE AS-CAST. TENSION TEST CURVE.

is increasing as a result of better co-operation between designers and founders, through which new applications and adaptations are found that previously were considered outside the scope of the foundry industry. Twenty years ago the average tensile strength of grey cast iron was given in most publications at 7 or 8 tons per sq. in., and irons giving a strength of 10 tons per sq. in. were considered as being of special quality. Even at the present time strengths very slightly in excess of this figure appear in textbooks and handbooks. Safe working loads are stated to be from 1½ to 2 tons in tension and from 5 to 7 tons in compression. It is not surprising, therefore, that there should have been a disposition on the part of the engineer to turn to steel castings and welded material for parts where more strength was required, in the belief that the use of cast iron was at an end. In recent years cast irons of greatly improved strength and reliability have been developed, and a comparison of the present specifications of mechanical properties offered by iron-founders with those of twenty years ago will prove a revelation to those who have not made a close study of the progress that has been made by founders.

Modern engineering progress involving the use of higher speeds, temperatures and pressures, together with the increase in the size of engines and machinery, has been facilitated in no small degree by the exertions of the founder and metallurgist. It appears probable that in the near future the engineer will make still further demands upon the founder and metallurgist for castings of even greater complexity to withstand more severe service conditions. The future progress of engineering design and construction will be greatly influenced by the degree of success achieved by the metallurgist in the production of material to conform to more stringent specifications as to mechanical properties, and by the founder in improving his technique so as to enable him to cast such material. In the past few years casting practice has kept pace with the requirements of engineers, and there is every hope that it will not only keep pace, but anticipate the requirements of progressive engineers in the future.

Enhanced Properties Now Available

Until the beginning of this century foundry practice remained an art rather than a science, and castings were not greatly improved to that time. The demands of the engineer were influential factors in changing iron founding from an art to a science. Rapid development of testing methods and calls for properties in excess of those found in the earlier cast irons led to more technical control and metallurgical knowledge in the foundry, enabling it to keep pace with exacting requirements. At the present time, by the careful selection of basic and alloying materials with strict foundry and metallurgical control, castings of uniformly high quality and covering a wide range of physical properties are manufactured regularly as commercial products. Ten years ago a request for cast iron with a tensile strength of from 16 to 18 tons per sq. in. was considered something exceptional. To-day cast irons with tensile strengths of from 25 to 30 tons per sq. in. are regular products of the cupola. In addition, the use of alloy additions and developments that have been made in heat-treatment have increased the possibilities of securing increased properties and a uniform quality of cast iron. The position has been reversed, and instead of cast iron being regarded as an obsolete material for engineering purposes it is in many instances being used in preference to steel castings and even forged steel. A striking illustration of the change in attitude of the engineer to cast iron is shown by the adoption of cast camshafts and crankshafts by the leading motor manufacturers. It is also a clear indication of the rapid developments that have recently been made in cast iron.

It is significant and of great promise that the material is encompassing everwidening vistas in mechanical industries where cost of production and long life are of paramount importance. With strength approaching 40 tons per sq. in. and a Brinell hardness of 500, it is displacing forged steel in parts where a short time ago it would have been considered impossible. It is true to say that the material commonly referred to as cast iron is now sought after by engineers for the particular properties and characteristics with which it is endowed.

Early Acceptance Tests

It is not the author's intention to deal with details of the various methods that have been

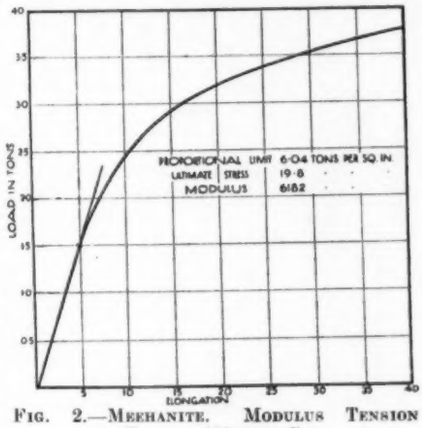


FIG. 2.—MEEHANITE. MODULUS TENSION TEST AT 400 DEG. C.

used in the manufacture of improved cast iron at various times, but rather to indicate the directions in which the improvements have been effected and the application to engineering work. It was early recognised that a cast-iron material showing a closer grain and a more regular structure was necessary to withstand the higher

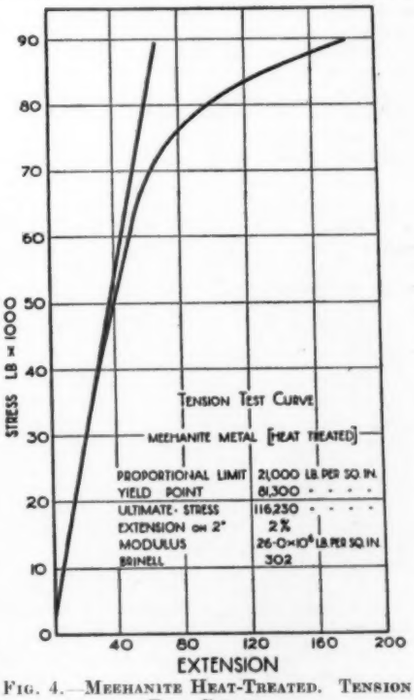


FIG. 4.—MEEHANITE HEAT-TREATED. TENSION TEST CURVE.

pressures and stresses demanded with the increasing size of machinery. The engineer, however, did not closely specify his requirements when ordering castings. It was usual simply to order a "good grey iron" without reference to service requirements, and to assume the safe working load at 4,000 lbs. per sq. in. The grey-

* A Paper read before The Institution of Engineers and Shipbuilders in Scotland.

ness of the metal was adjudged solely by the appearance of a fractured surface of a small test bar or runner, and the suitability or otherwise of the casting for the job was determined from the fracture appearance alone or with the additional information obtained from the breaking of a roughly-cast transverse test bar. It is not surprising that cast iron came to be regarded as a weak and unreliable material having a field of usefulness confined to the unimportant parts of machines. Regarded from a strictly metallurgical point of view, ordinary grey iron is intermediate between pig-iron unrefined and steel. It differs from true alloys of ferrous base by containing particles of free carbon or graphite dispersed throughout the mass, and it is this peculiarity of certain grey cast irons that is responsible for the low strength, mechanical weakness and inconsistencies in service of castings from foundries working under inadequately controlled conditions.

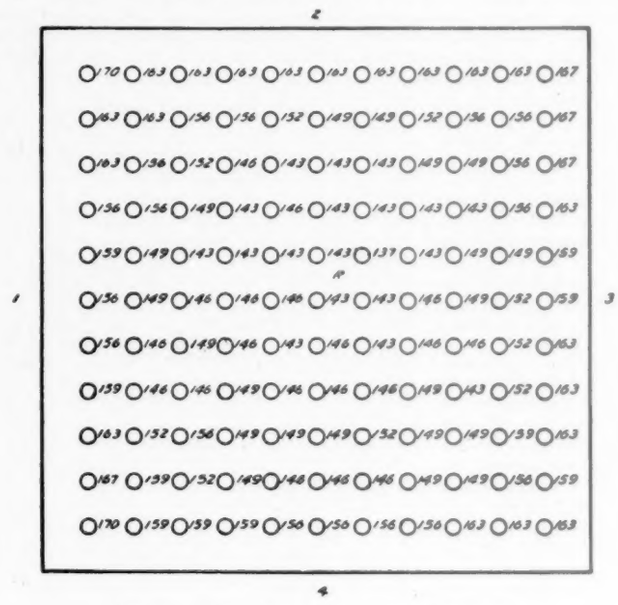


FIG. 5.—GREY IRON BLOCK 12 IN. SQUARE.

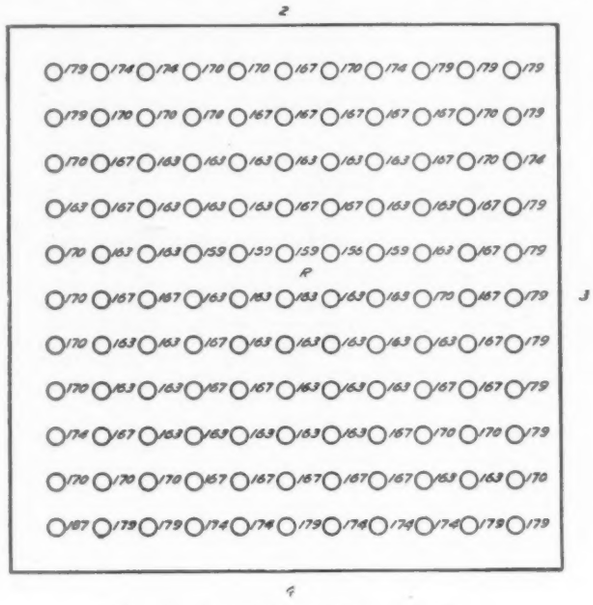


FIG. 6.—ALLOY BLOCK 12 IN. SQUARE.

High-Test Irons

The past twenty years has seen much activity in the study and discussion of the methods of manufacturing improved cast irons, their properties and applications, and the results of the different efforts to attain the same object are the superior irons being produced to-day. The present-day high-test irons have evolved from a number of contributory causes, namely:—

(1) The unreliability of ordinary cast irons under severe service conditions in engineering construction where small factors of safety are necessary.

(2) The latent but undeveloped possibilities of ordinary cast iron.

(3) The necessity of lifting ordinary grey iron out of the commonplace and giving to the founder an opportunity to confer individuality to his product.

(4) The need of meeting the keen competition of steel castings, forgings and stampings, and welded constructions.

There may be a difference of opinion as to which of these is the most important, but it is probably agreed that while the engineer may be willing to pay more for improved material or new properties, the ultimate price will reflect what these properties cost in competitive materials. High-test cast iron is not new, but progress in its production has been slow, because although many of the new processes showed what could be obtained from properly made or treated cast iron, they never became established practically in the foundry or found their place in competitive production. This has been due to the failure of the average founder to appreciate what is involved in the manufacture of high-quality cast iron, particularly as some of them do not recognise the fundamental importance of metallurgical knowledge and supervision.

The chief features of the processes that have been introduced for the production of high-test cast iron are:—

(1) The use of steel scrap or lowering of the silicon content in the charge.

(2) Lowering the total carbon and phosphorus contents.

(3) Superheating in melting.

(4) Control of graphitisation by chemical composition or rate of cooling during solidification.

So far as (4) is concerned, the greater the amount of carbon contained in the iron, the greater is the difficulty in controlling the form and distribution of the graphite and the grain of the matrix, both of which are of equal importance in the determination of the physical properties of a casting. On the other hand, the lower the total carbon content, the more difficult it is to obtain a uniform softness and homogeneity of the structure of the casting. In addition to those mentioned above, another well-known method of conferring enhanced properties upon cast iron is by means of alloy additions, usually nickel, chromium, molybdenum and occasionally titanium, vanadium, tungsten, and silicon. The improvements effected by alloy additions, however, are more noticeable from the point of view of specialised applications, such as resistance to corrosion or heat, than from the point of view of increased strength. Two types of alloy iron are available. In one, sufficient of the alloy is added to modify the basic structure of the metal in the as-cast condition, or to permit of a modification by heat-treatment. The other type, known as "austenitic iron," is produced by large additions of alloys and is suitable mainly for special purposes where severe corrosion has to be resisted. The present Paper does not deal with austenitic irons.

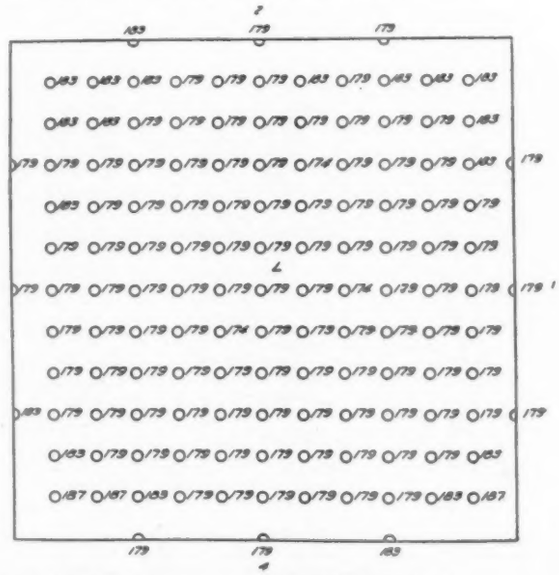


FIG. 7.—MEEHANITE B BLOCK 12 IN. SQUARE.

Graphite Control

Almost all the methods that have been developed to improve the properties of cast iron have consciously or unconsciously attempted to control graphitisation, whether resort has been made to the use of steel in the mixture, whether

carbon and silicon have been reduced by special mixtures in melting conditions, whether superheating of the molten metal has been effected, whether hard iron has been graphitised by pouring into heated moulds, or whether alloys or heat-treatment have been involved. The results of all these different methods of attempting the same object are seen in the superior cast irons available to-day, although progress has not been proportional to the scientific attention and research that have been applied. This can be partly explained by the necessity of retaining the identity of what is usually understood as "common cast iron" together with an economic advantage over steel. In other words, to hold and extend his field the producer must furnish castings that are consistently uniform and have a superior combination of physical properties, without involving the costly processes and increased care that is necessary for the manufacture of a completely refined ferrous-base alloy, whether it is a steel or any other alloy casting, stamping or forging. The highly developed technical and plant efficiency of the latter and their low cost of production have, as it were, tied the hands of the average foundryman in his attempts to improve his product and still retain some commercial advantage over other products made in steel, malleable iron, aluminium alloys or bronze.

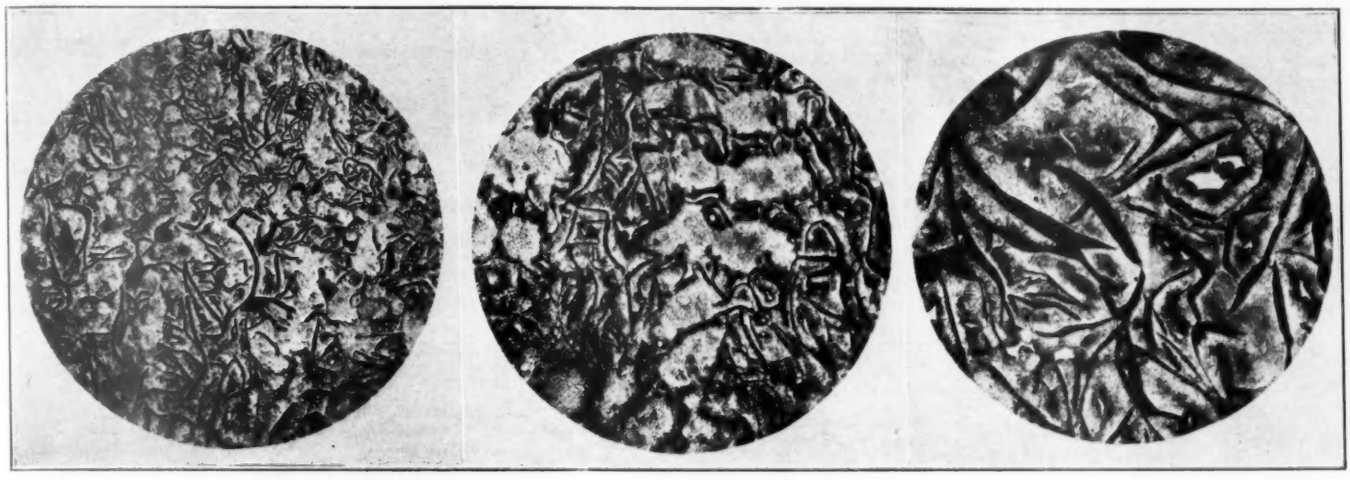
The principal factors influencing the properties of cast iron are:—(1) The chemical composition; (2) the structural composition; (3) the melting process; (4) the thermal and mechanical history between furnace spout and cold casting; (5) the subsequent heat-treatment, and (6) design.

Chemical Analyses and Structure

The chemical composition is mainly important in its effect on other factors. If factors (2) to (6) remain constant, then the properties of the metal may depend on composition. Where castings are obtained from one foundry, factors other than composition may, for most practical purposes, be considered constant, and specifications may logically include composition; but where the engineer buys castings in the open market, an initial specification of chemical composition is not likely to be of much value. Different foundries employing different methods and different processes may produce irons of practically the same engineering properties with different compositions. The engineer is concerned with the mechanical properties of the metal, and so long as these are satisfactory, and the castings sound, the means used to secure them are of secondary importance. The engineering properties and service life of castings depend on the structural composition and degree of soundness, so that the study of the structure of the metal is the important consideration. The majority of commercial cast irons contain four main constituents, namely, graphite, ferrite, pearlite and phosphide eutectic, together with certain minor inclusions of which perhaps sulphide of manganese is the most important. Tables I and II show the ultimate chemical analyses of three cast irons and the corresponding structural constituents.

TABLE I.—*Chemical Analysis.*

No.	Gr.	C.C.	Si.	Mn.	S.	P.	Fe.
1	2.10	0.80	1.10	0.75	0.07	0.20	94.98
2	2.50	0.70	1.80	0.80	0.10	0.32	93.78
3	3.09	0.40	2.40	0.55	0.11	1.05	92.40



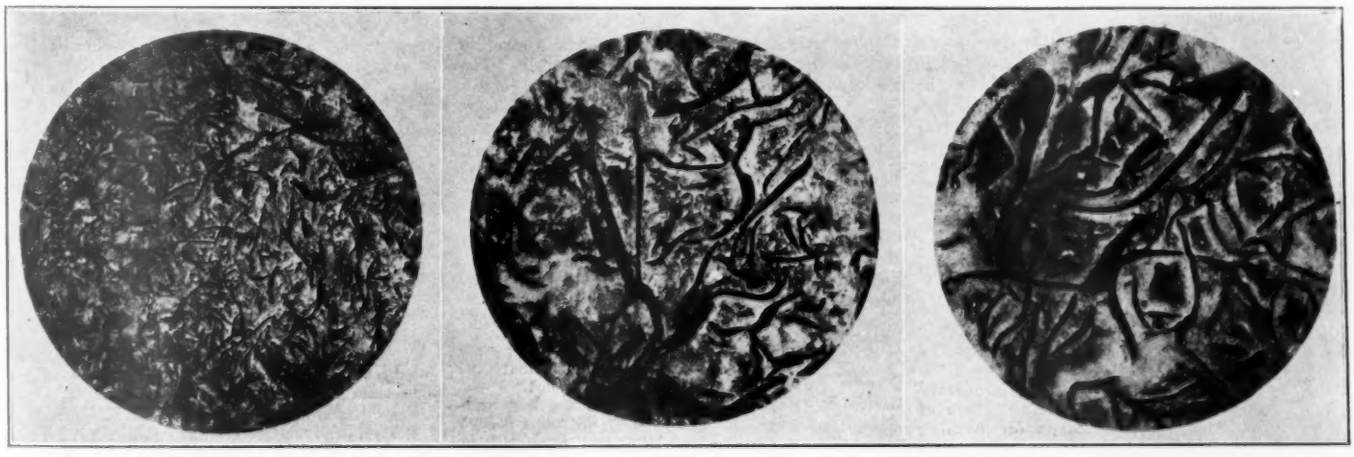
2 IN. 6 IN. 12 IN.

FIG. 8.—INFLUENCE OF MASS ON STRUCTURE OF GREY CAST IRON. × 100 (REDUCED ON REPRODUCTION BY ⅔).

Mass and cooling rate have a profound influence on the structure of grey irons. An iron of such a composition as to be pearlitic in medium-sized sand castings may become white if cooled rapidly enough, or many become ferritic and open if cooled very slowly. In a casting of varying section the relative cooling rates of the different parts are approximately proportional to the section size.

TABLE II.—*Structural Composition.*

No.	Gr.	Ferrite.	Pearlite.	MnS.	FeS.	Fe_3P.
1	6.70	6.36	84.59	0.35	—	2.0
2	7.87	15.65	72.84	0.49	—	3.15
3	9.51	39.14	40.75	0.48	—	10.12



2 IN. 6 IN. 12 IN.

FIG. 9.—INFLUENCE OF MASS ON STRUCTURE OF ALLOY CAST IRON. × 100 (REDUCED ON REPRODUCTION BY ⅔).

The author has already referred to the difficulty of maintaining uniformity and homo-

geneity of structure with either high or low total carbon contents. Steel is used to control the quantity of carbon and to give a pearlitic or sorbo-pearlitic matrix, and it is to its ability to effect such a structural condition that mixtures containing steel give superior strength, density and hardness. Superheating in melting is also generally recognised as exerting a similar effect to steel additions in refining the graphite and giving the necessary strength through ensuring the carbon existing in combination rather than in the free state. There still remains the problem of accurate and uniform decomposition of the carbide so that the deposited free carbon may be well dispersed throughout the metal.

Meehanite

In 1926 Meehan experimented in the manufacture of a grey iron of superior strength and physical properties. The development of this type of iron has been carried on by Smalley and others until at the present time it represents the greatest advance that has ever been made in the metallurgy of cast iron. The particular type of high-test iron made by Meehan's process and known as "Meehanite" can be controlled to meet definite service requirements, and possesses superior physical qualities to cast iron or semi-steel. Meehanite methods permit of absolute control, removing uncertainties and resulting in a material which can be relied upon at all times to give the properties called for. The advantages of Meehanite metal are that the physical properties are accurately controlled and guaranteed to a definite specification and uniform strength and solidity. Of recent years the author has had special opportunities of studying the development of this type of high-duty cast iron, and if in what follows it appears to be given undue prominence, this is not intended as a reflection on other high-duty cast irons, but merely that the author is recording his own experience.

Most modern engineering textbooks describe cast iron as a material that does not give a straight line relationship between stress and strain in tension. In other words, it does not possess true elastic properties. It is also classed as a brittle material, which is probably true of ordinary grey iron, and is meant for nothing but the free-cutting ornamental variety. This conception of grey iron is not entirely the fault of the engineer: metallurgists and foundrymen have not fully appreciated the engineer's point of view. Tensile tests on grey iron to obtain accurate measurements of elastic constants require special equipment and are not easy to make; hence concentration has been on the transverse test because it can be made easily and cheaply. In this test, load and deflection values are determined and substituted in the well-known beam formulæ to obtain modulus values. Values thus obtained are of doubtful importance as they appear to vary for the same material under different conditions of testing. An instance is found in a Paper by Adamson and Bell,* who state that a grey iron tested transversely gave a modulus value, computed on the basis of deflection at fracture, of 11.5 million lbs. per sq. in. with a test bar 1 in. square over a 36-in. span. The same material with a 1-in. square bar tested over a 12-in. span gave a modulus value of 6.5 million lbs. per sq. in. Presumably the material on both bars was the same yet the results show so large a difference. In design work the engineer requires to know definitely the numerical value of E because it is one of the most important constants. If he uses steel, very little error arises by using 30×10^6 lbs. per sq. in., as the steel in general gives that average figure. According to the Paper just referred to, the variation with cast iron may be from 6 to 10 millions, and it would be impossible for the designer to have confidence in his calculations.

Figs. 1 and 2 show the modulus curves taken on a cast iron made by the Meehanite process, the former tested at atmospheric temperature and the latter taken at a temperature of 400 deg. C. Figs. 3 and 4 show modulus curves of an iron in the as-cast and heat-treated conditions respectively. These curves show a straight line relationship between stress and strain. The modulus of the irons is shown as follows:—

Curve No.	1.	2.	3.	4.
Modulus, lbs. per sq. in. $\times 10^6$	19.28	14.426	19	26

The true elastic limit of the material represented by Figs. 3 and 4 is 6.4 tons per sq. in. with a yield point of 21 tons in the as-cast condition and 9.5 tons per sq. in. with a yield of 27 tons in the heat-treated condition.

Service requirements ordinarily place a casting in one of the following classes:—

	Requirements.
1. General engineering	Strength, toughness, pressure tightness and machinability; resistance to shock.
2. Heat resistance ..	Retention of strength at continuous or intermittent high temperatures; permanency of form.
3. Wear resistance ..	Resistance to abrasion and erosion; freedom from galling or seizing under severe conditions.
4. Corrosion resistance	Resistance to the action of acids and alkalis, etc.
5. Chilled	Great hardness accompanied by toughness.

Modern cast irons of the Meehanite type are accurately controlled to a definite specification to meet the service requirements in the highest degree. The metal of each single casting may be changed to meet a given set of conditions in the way of mass influence as it affects strength, hardness and machinability, so that uniform strength properties in castings of varying section are assured. The uniformity of Meehanite iron in comparison with a 15 per cent. semi-steel iron and a nickel-chromium-molybdenum, alloy cast iron, poured into 12-in. cubes, is shown in Figs. 5, 6 and 7, which represent hardness determinations made on a section through the centre of the cubes. It will be observed that there is a regular and gradual falling-off in the Brinell figures from the outside to the centre of the piece in both the grey iron and the alloy iron, whilst in the Meehanite, apart from a slight increase at the corners, the hardness is uniform throughout the section. The same three irons were poured into a series of bars each 12 in. in length and with sections of 2 by 2 in., 4 by 4 in., 6 by 6 in., 8 by 8 in., 10 by 10 in., and 12 by 12 in. Each set was poured at the same time from the same ladle. The structure of the 2-in., 6-in. and 12-in. blocks of each type of material is shown in the photomicrographs, Figs. 8, 9 and 10. The greater uniformity of the Meehanite metal is evident, as also is the fact that alloy additions alone do not in any way promote uniformity of structure in castings of varying section. The engineer is interested in the mass influence on the ultimate strength of the material employed and to what extent he can depend upon the load-carrying capacity of different sections. In Table III are shown the results of tensile tests made on bars cut from the section used for the hardness testing of the

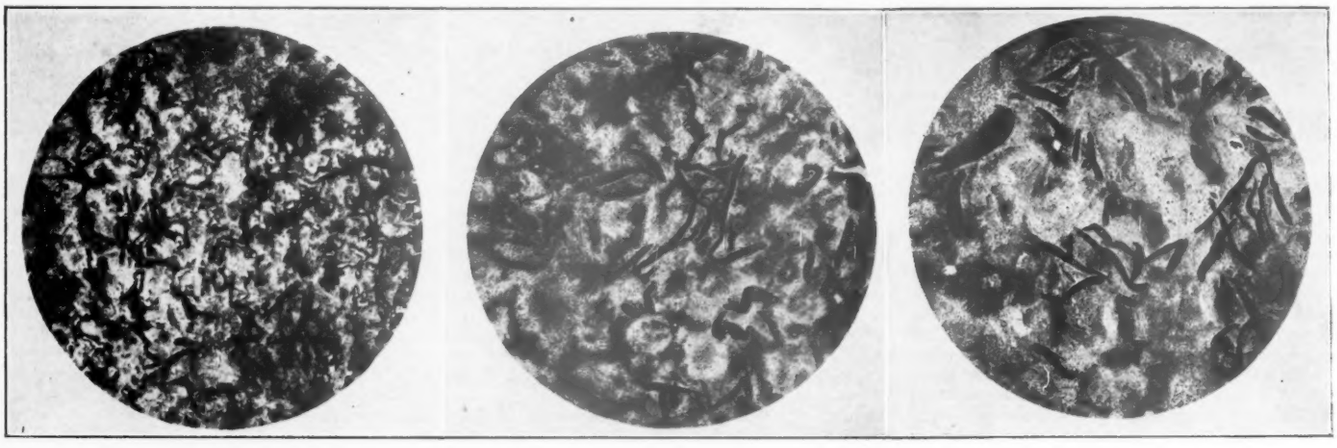
(*Concluded on page* 158.)

TABLE III.—*Mass Influence on the Tensile Strength of Various Irons.*

	4-in. sq. block.			2-in. sq. block.
Position from which test bar was cut, in. from side	$\frac{9}{16}$	2	$\frac{7}{16}$	1
Tensile strength, tons per sq. in.—				
Semi-steel	13.7	10.8	14.0	13.5
Alloy iron	16.5	13.1	16.7	15.5
Meehanite	20.8	19.1	20.4	22.1

Standard test bar, 0.798 in. dia.

	Semi-steel.	Alloy iron.	Meehanite.
Tensile strength, tons per sq. in. ..	17.7	20.9	22.8
Strength of test bar, in 2-in. section, per cent. ..	76.2	74.1	96.5



2 IN. 6 IN. 12 IN.

FIG. 10.—INFLUENCE OF MASS ON MEEHANITE CAST IRON. × 100 (REDUCED ON REPRODUCTION BY $\frac{2}{3}$).

* Iron and Steel Inst. Carnegie Schol. Mem., 1927, Vol. 16, p. 1.

Quantity Production of Railway Steel Castings in Canada

By E. G. FIEGEHEN, M.I.Mech.E.

(*Continued from page* 140.)

Sand Storage

The arrangement of sand storage hoppers and duct work received a great deal of consideration and involved many re-arrangements of the original proposals, but it was considered that the layout finally adopted met the requirements particularly well, without the sacrifice of general simplicity.

A diagram of the arrangement adopted is shown in Fig. 5. Having in view the requirements of subsequent maintenance, it was further decided that the corresponding renewable parts of each system should, as far as possible, be alike and interchangeable, and further, that the number of sizes of driving motors and of their starting equipment should be reduced to the minimum and this was satisfactorily arranged.

Each sand system was to consist of two independent units:—(*a*) Equipment for handling and conditioning floor sand shaken from the moulding boxes, and (*b*) somewhat similar equipment for reclaiming core sand, knocked out of the castings.

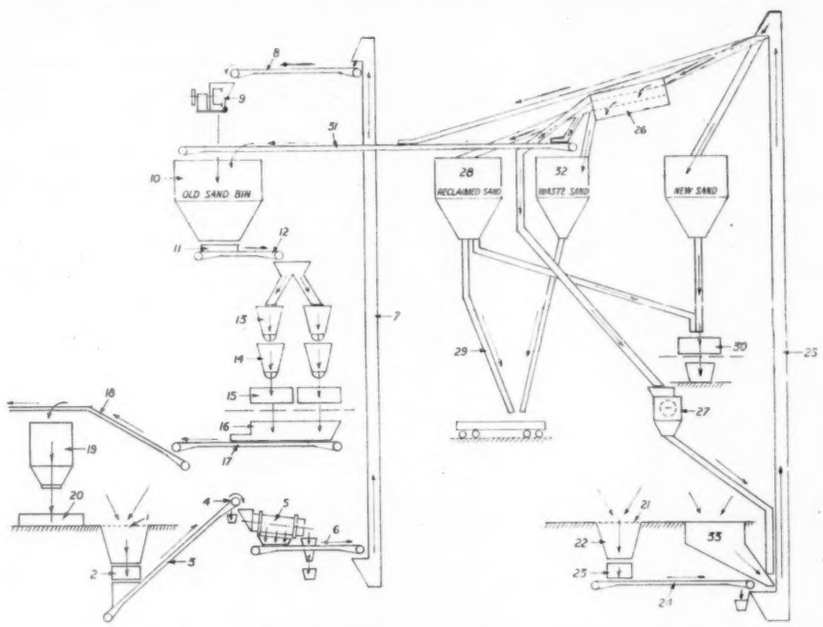


FIG. 5.—SAND SYSTEM FOR SIDE-FRAME AND BOLSTER MOULDING DEPARTMENT.

Further, provision was required for the introduction of new sand into both equipments if required. Owing to the severity of the Canadian winter, the whole of the equipment located outside the foundry had to be enclosed, in suitable housings, with provision for heating.

Sand System for Side-Frame and Bolster Moulding Department

The sand system supplying the side-frame and bolster department, which is typical of both systems, is located, longitudinally, approximately between columns Nos. 4 and 8 on the east side of the aisle (Fig. 4).

Near the centre of the aisle (8, Fig. 4) is located a "shake out" grating (1, Fig. 5) measuring 20 ft. by 12 ft. and flush with the foundry floor. This grating is built up in sections, of convenient size, which rest upon transverse joists spanning the top of a large sand hopper, with inclined sides and base. A large reinforced-concrete pit was provided, below the floor-line, for the accommodation of this hopper and the 36-in. apron feeder, 43-ft. centres (2, Fig. 5), to which it delivers the shake-out sand, and the motor and gearing for driving the feeder. This chamber was well lighted and drained to a sump well, which was emptied by an automatic electric pump.

The apron-feeder was arranged to travel at the comparatively low speed of 15 ft. per min., to give time for the hot sand to cool before transfer to an inclined 24-in. troughed rubber-faced canvas belt conveyor, 57-ft. centres, running at a speed of 140 ft. per min. (3, Fig. 5 and illustrated in Fig. 6) and supported upon ball-bearing idler rollers.

On this belt the sand is elevated from the pit and, at the end of its travel, passes over an 18-in. dia. magnetic pulley (4, Fig. 5), which removes all iron objects such as nails and gaggers, into a small hopper placed below, and discharges the sand itself into the hopper of an electrically-driven revolving screen, 48 in. dia. by 6 ft. long on the screening surface (5, Fig. 5). Inside this screen, longitudinal channel-steel lifters are fitted, which scoop up the sand, as the screen revolves, and let it fall, repeatedly, to break up the lumps.

Such sand lumps and foreign matter that cannot be broken in this way fall into a tailings hopper at the end of the inclined screen drum, whilst the screened sand falls into a hopper and on to a 24-in. flat rubber-faced belt (6, Fig. 5) below and is conveyed into the boot of a vertical bucket-elevator (7, Fig. 5), 51 ft. centres, having 14-in. by 8-in. buckets bolted to a 15-in. canvas belt. This elevator is totally enclosed by a sheet-steel casing, having removable panels for inspection, and is driven by an independent motor and gearing at its top. From the head of this elevator the sand is discharged on to a 30-in. flat "tempering" belt (8, Fig. 5).

In its passage along this belt the sand is damped to requirements by a series of water-sprays from an overhead pipe, and is then discharged into the hopper of a 48-in. dia. "conditioner" (9, Fig. 5, and illustrated in Fig. 7), which consists of a rotating "squirrel cage," made of Norway iron bars, riveted to a driving disc and to an outer reinforcing ring. The whole is enclosed in a sheet-steel casing and arranged for belt driving.

FIG. 6.—TROUGHED RUBBER-FACED CANVAS BELT CONVEYOR FEEDING SAND HOPPER.

The sand, falling into the revolving cage, is battered and separated by the revolving bars and becomes thoroughly aerated, finally falling, through the bars, into the large "old sand" hopper (10, Fig. 5) of 150 tons capacity, immediately below it. This hopper is constructed of steel plate, reinforced by channels and has a taper bottom, for discharge. It is supported by steel columns, properly braced, and its top is about 40 ft. above the foundry floor level.

FIG. 7.—48-IN. DIA. SAND CONDITIONER.

When the sand mills require sand from this hopper, it is discharged, from its bottom, by means of a "cutting feeder" (11, Fig. 5) consisting of a framework of parallel flat bars

(2½ in. by ⅜ in.), spaced about 1 in. apart. These bars are pivoted at one end to fixed pins, whilst the opposite ends are connected, by pins, to a bar which is reciprocated by a variable-throw crank driven by a motor and gearing.

When the frame is at rest, the moist sand arches over the openings but will not fall through, but when the frame is reciprocated, the edges of the bars slice the surface of the sand, above them, and give a very satisfactory, well-distributed and easily-regulated feed.

The sand, from this feeder, falls upon a short horizontal belt (12, Fig. 5) driven by the same motor, which is controlled from the sand-mill platform, into a breeches-pipe which conducts it into intermediate hoppers (13, Fig. 5) where it accumulates, ready for discharge when required, through double-sector under-cutting gates, into the two measuring hoppers (14, Fig. 5) one of which is located above each sand-mill. These hoppers also have undercutting gates, which when opened, rapidly discharge a measured batch of sand (2,500 lbs.) into the pan.

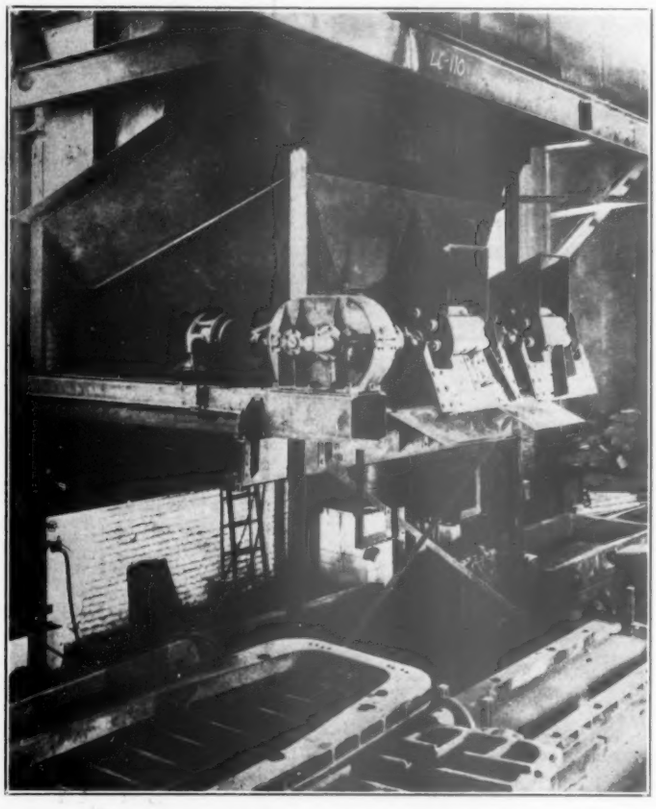


FIG. 8.—40-TON STEEL PLATE HOPPERS FOR FEEDING MOULDING MACHINES.

The sand-mills (15, Fig. 5), of which there are two, in this system, are of the type known as "Simpson intensive sand mixers" and have 8-ft. dia. fixed pans, with renewable bottoms, and two 36-in. dia. by 11-in. steel-tyred, rotating sand mullers or rollers. These are fitted into anti-friction journal and thrust bearings and rotate on the ends of a crosshead, keyed to a vertical shaft driven by bevel-gearing below the pan, the pinion of which is driven, through enclosed machine-cut gearings, by a 50-b.h.p. motor.

Anti-friction bearings and flexible couplings are used throughout and each machine, with its motor and driving gear, is mounted upon a heavy reinforced concrete base. Each mill mixes, normally, a 2,000- to 2,500-lb. batch of sand.

Water-sprays, arranged around the pan, are provided for wetting the mixture, as required, and the sand, after milling, is discharged through pneumatically-operated doors in the bottom of the pan, into a hopper (16, Fig. 5) of the full capacity of the mill, which feeds it, under the control of a regulating gate, on to a collecting belt under the mills (17, Fig. 5), which in turn transfer it to the main distributing belt (18, Fig. 5), 24 in. wide and 313 ft. centres, which inclines upwards after leaving the mill, until the required elevation is reached, and then runs down the aisle, at an elevation of about 20 ft., alongside the crane runway girders (Fig. 8).

Supporting brackets for its framing, idler pulleys and platform, are bolted to the crane columns and at intervals along its length, deflecting ploughs are arranged, to discharge sand, through shutes, into the hoppers (19, Fig. 5) of the moulding machines (20, Fig. 5) below. When required, sand can also be discharged over the north end of this belt into a shute, to fill sand-boxes handled by the cranes. An independent motor and gearing is provided for driving the belt and is located at its northern extremity. A boarded footwalk and handrail runs the full length of the belt and serves, also, as a convenient landing for crane operators; a guarded ladder is provided for access from the floor.

For the supply of facing sand, an existing 8-ft. dia. rotating-pan sand mill was reconditioned, fitted with independent electric drive and mounted upon a concrete foundation, alongside the "Simpson" mills and at a sufficient elevation to discharge into sand boxes on the foundry floor. Sand for this mill is supplied through shutes from the main sand hoppers.

Moulding Machine Hoppers

Steel-plate hoppers (19, Fig. 5), each of 40 tons capacity, were installed for the service of the two new moulding machines, and these receive sand from the main distribution belt (Fig. 8). Each hopper is fitted with two 18 in. apron feeders, coupled and running side-by-side and driven by an independent motor and gearing, controlled from the moulding-machine operator's station by means of push-buttons. These feeders discharge sand, from an elevation of about 10 ft., directly into the box on the moulding machine in a broad stream. By adjusting short angle-iron deflectors, bolted to the apron-plates the density of this stream, along its width, can be varied to suit the distribution of sand required in the mould, whilst the total amount discharged can be regulated to a nicety by control of the motor. When properly adjusted, very little sand is spilled, and jolting of the mould can commence as soon as the sand commences to fall into the box, ramming being completed in about one minute.

In the case of the two old moulding machines, that were retained for dealing with short orders, all ramming had to be done by pneumatic hand rammers, and the output of moulds and demand for sand was relatively small. Wooden hoppers were provided alongside these machines and fed by shutes from the main distributing belt. The sand was shovelled from openings at the base of the hoppers into the moulding boxes.

Roller conveyors on the floor, and overhead runways were arranged for facilitating production in this pair of machines in a manner to be described later in conjunction with the description of the larger moulding machines.

(To be continued.)

Cast Iron and Its Applications in Engineering

(Concluded from page 156.)

2-in. and 4-in. blocks referred to above, together with results on standard test bars cast at the same time.

In order to obtain further information of the mass influence on strength, various foundries were invited to supply bars of 0.75, 1.25, 2.0 and 3.0 in. in diameter from which tensile test bars were prepared and tested. The average results are shown in Table IV. The ordinary grey cast iron has lost almost half of its strength in the 3-in. section, whilst the high-grade iron has retained practically full strength at the same thickness and approximately 90 per cent. in the 6-in. section. This is one of the outstanding features of the new process. Because of this uniformity the strength of a machine element is directly proportional to its cross-sectional area, and in designing, assurance is given that here is a cast iron that is dependable in the engineering sense, and confidence that every square inch of cross section carries its full share of load.

TABLE IV.

Diameter of bar from which test bar was cut.	Tensile strength, tons per sq. in.	
In.	Grey iron.	Meehanite.
0.75	12.3	—
1.25	11.6	23.95
2.0	8.25	24.25
3.0	6.8	23.7
4.0	—	22.7
6.0	—	21.2

(To be concluded.)

The King and National "Safety First" Association

The King has extended his patronage to the National "Safety First" Association. As Duke of York, he was patron of the Association from 1926 until his accession, while from 1923 to 1926 he was President of the London "Safety First" Council. Throughout the whole period of his connection with the Association, the King has shown a keen interest in all sides of accident-prevention work.

Influence of Elements on Cast Iron

At a joint meeting of the East Midlands Branch with its Lincolnshire Section, held at the University College, Nottingham, on January 23, MR. H. BUNTING, Branch-President, said, in introducing Mr. A. E. Peace, a Past-President of the Branch, that this was the second successive Paper to be given by a member of the Branch, which was a very pleasing feature. He was sure that the subject would be handled very efficiently, and would lead to a good discussion.

MR. PEACE then gave his Paper. He said that when requested to present a Paper upon the metallurgy of cast iron, he had interpreted it to mean a purely educational discourse, and consequently he had selected as his title "A Refresher in Cast Iron Metallurgy," which suggested the rehearing of previous studies.

As it was impossible to treat the metallurgy of cast iron very comprehensively in the space available, one phase of the subject only will be considered. The subject will be approached from the metallographical aspect, and will treat of the effect of composition and thermal history upon the structure of the metal. Mr. Peace illustrated the iron-carbon equilibrium diagram, and explained the components making up the system.

The lecturer illustrated by micrographs many phases of his subject, and pointed out that the specific gravity of graphite in cast iron was low, about 2.25, and that graphite therefore occupied a larger volume than its gravimetric percentage indicated, *e.g.*, 2½ per cent. of graphitic carbon in cast iron was approximately 10 per cent. by volume.

The effect of graphite on the strength of cast iron was not due so much to its own inherent weakness, but rather to the manner in which it broke up the continuity of the metal. In fact the structure of the graphite was of more importance than its quantity, and iron with a very fine graphite structure could be stronger than another iron with less graphite when it was present in a much coarser form. The strength of the metal was adversely affected by increase in the amount of graphite in the size of the flakes and by poor distribution.

Effect of Other Elements

MR. PEACE said that in a general way and with certain limitations additional elements could be divided into two groups (1) those favouring graphitisation which include silicon, nickel, aluminium and copper, and (2) those inhibiting graphitisation such as sulphur, manganese, phosphorus, chromium and vanadium. An element may (1) dissolve in the iron forming solid solution, *e.g.*, silicon; (2) it may form a carbide, usually entering into combination with the iron carbide in the cementite, as for example, chromium; (3) it may form a so-called metalloid like sulphur which forms manganese sulphide and ferrous sulphide; (4) it may partake of two or all of these formations such as manganese which combines with the sulphur to form manganese sulphide and may form manganese-carbide and also may be in solution in the ferrite. In general the elements which form solid solutions favour graphitisation and those which form carbides hinder graphitisation.

Silicon

Silicon which may be present in ordinary cast irons from 0.25 per cent. to 3.00 per cent., enters into solution in the iron as previously stated. It somewhat hardens the ferrite and weakens it, though generally these effects are completely masked by other factors. It lowers the carbon content of the eutectic by somewhere around 0.30 per cent. for each 1 per cent. of silicon, and also lowers the carbon content of the eutectoid. Silicon is more powerful in decreasing the stability of iron carbide and thus promotes graphitisation. This, of course, is the chief function of silicon in cast irons and is the reason why silicon is the most important element in the control of the structure and properties of cast iron, and when in excess of 4 per cent., it causes almost complete graphitisation. On account of the hardness and brittleness of the solid solution such a metal is little used except for heat-resistance and in this respect high silicon iron is especially valuable. An example of such a metal is "Silal" introduced by the B.C.I.R.A.

Manganese

Manganese is present in cast irons from 0.1 to 2.00 per cent. The majority of good quality cast irons carry from 0.4 to 1 per cent. This element combines with sulphur to form manganese sulphide which is insoluble in the iron. This sulphide can be seen under the microscope generally as round particles, grey in colour. The sulphide is distributed haphazardly in the metal and has little effect upon the physical properties. The amount of manganese required completely to take the sulphur into combination is in excess of the theoretical quantity by 0.2 to 0.4 per cent. Thus with a suitable manganese the effect of sulphur is nullified; any residue of manganese after the formation of the sulphide forms manganese carbide which unites with the iron carbide to form cementite. This manganiferous cemenite is more stable than iron carbide, so that manganese, when present above the amount necessary, neutralises the sulphur, inhibits graphitisation, and is a hardening element; in irons which are composed predominantly of ferrite, excess manganese is in solid solution.

Sulphur

Sulphur is present in cast iron in quantities ranging from a mere trace to around 0.4 per cent. In general, grey cast irons will contain from 0.008 to 0.15 per cent. Sulphur, in the absence of manganese or with insufficient manganese to form manganese-sulphide, combines with iron as ferrous-sulphide. This constituent can be seen under the microscope as round yellowish areas. It is thought that some ferrous-sulphide dissolves in the cementite and increases its stability, for when sulphur is present with insufficient manganese, the carbide is very stable and cannot be readily graphitised. An excess of sulphur is used in whiteheart malleable to prevent graphitisation, and sometimes in chilled castings to increase the depth of chill. Where blow holes and unsoundness result from poor melting practice, high sulphur probably increases the troubles.

The idea that sulphur is a harmful element and always productive of trouble is incorrect, and first class quality cast iron can be made with sulphur appreciably in excess of 0.1 per cent.

Phosphorus

Phosphorus is usually present in quantities from 0.06 to 2 per cent. It lowers the carbon content of the eutectic and it combines with iron to form iron phosphide, and when present in a very small quantity this dissolves in the iron and is not microscopically discernible. In the quantity usually found in cast irons the phosphide is not completely held in solution, and nearly all of it forms in some circumstances a binary eutectic of phosphide and iron and a ternary eutectic of phosphide iron carbide and iron. These compounds are called steadite, or, more commonly nowadays, the phosphide eutectic, and it is not usual to find a distinction made between the two eutectics. One per cent. of phosphorus produces about 10 per cent. of eutectic, and as the eutectic has a melting point of 950 to 1,000 deg. C., it will be seen that high phosphorus irons are more fluid. The eutectic is hard and therefore high phosphorus irons tend to decrease machinability, but its effect on strength is not so marked as it was at one time thought. As the phosphorus increases the iron is somewhat weakened, and it is not usual to attempt to make high strength irons with phosphorus above 0.8 or 0.9 per cent. As the eutectic occupies an appreciable volume, the combined carbon required to form a pearlitic matrix is less with increasing phosphorus. Phosphorus has little direct effect on graphitisation, its action being such as may occur by the lowering of the carbon of the eutectic and the lowering of the liquidus and solidus, which is occasioned by phosphorus. In addition, when the ternary phosphide eutectic is formed this holds more carbide of iron, which, however, will graphitise under suitable conditions. In general, phosphorus is regarded as exerting a restraining effect upon graphitisation.

Nickel

Nickel is used in cast irons in quantities from 0.5 per cent. upwards. Above 4 per cent. its use is confined to irons for specific purposes, which will be mentioned later. This element forms a solid solution and favours graphitisation. It slightly reduces the carbon content of the eutectoid and has a valuable effect in making irons less susceptible to the cooling rate, *e.g.*, there is less evidence of mass effect in nickel cast iron, and chill can be reduced without loss of hardness in the grey portion. With the same hardness and strength a nickel cast iron is more easily machined than an ordinary cast iron. It is usual in alloying nickel to reduce the silicon content so that graphitisation is similar, and under these conditions the hardness and strength in different sections is more uniform and the density is improved. As nickel is increased above 4 per cent. the austenite change to pearlite is restrained. In some cases use is made of nickel to produce a martensite structure which has great heat and corrosion resistance. About 15 per cent nickel produces an almost completely austenitic structure.

Chromium

Chromium is used in quantities from 0.3 per cent. to 2.0 per cent. For special purposes some irons are made with 15 to 30 per cent. Chromium forms a carbide which enters into combination with the iron carbide in the cementite, and this cementite is exceedingly stable. Above 1 per cent. chromium the complete breaking down of free cementite is prevented, and at around 3 per cent. no graphitisation takes place. Chromium increases the depth of chill and hardness, reduces the size of the graphite flakes, and, under suitable conditions, an increase in strength can be obtained. In order to reduce the excessive carbide formation and hardening obtained by chromium, nickel is frequently used in conjunction with it, usually in the proportion of 2½ nickel to 1 of chromium. Such alloy irons give improved strength and wear resistance and uniformity of structure and physical properties in varying sections. Large quantities of chromium are used, *e.g.*, over 15 per cent, to produce heat and corrosion resisting irons. Such metal has a white fracture, is unmachinable and possesses a structure of very fine carbides.

Molybdenum, Vanadium and Copper

Molybdenum is a useful alloying element which is now being used in quantities from 0.25 to 1.5 per cent. It forms a carbide, enters into solid solution, and restrains graphitisation, but to a much less degree than chromium. Molybdenum has a beneficial effect in reducing the size of the graphite flakes, and it tends to produce a more nodular form. Increases in strength and hardness and more uniformity in varying sections are obtained when this element is incorporated in cast iron. Its use, however, is considerably limited by its high cost.

Vanadium, which is sometimes used in cast irons in quantities up to 0.5 per cent., forms a carbide which stabilises the cementite to a

greater degree than any other element. It reduces graphitisation, increases the depth of chill and hardness of the metal, and, when suitably used, it gives improved strength.

Copper, when used in cast irons in quantities of 0.5 to 1.5 per cent., enters into solid solution in the iron. This solid solution is somewhat harder and stronger than the copper-free irons. This element slightly favours graphitisation, and the solid solution shows resistance in mild corrosion such as atmospheric smoke and slightly acid water and it is chiefly for this property that copper is used in cast iron.

Finally, the author expressed his thanks to Dr. A. B. Everest for the loan of some of the lantern slides, to Mr. Greatorex, who specially made a number of illustrations, and to Mr. Philip Russell, who sponsored the publication of "Typical Microstructures of Cast Iron" by the Technical Committee of the Institute of British Foundrymen, from which negatives a number of the lantern slides were made.

DISCUSSION

MR. BUNTING emphasised the use by the student of metallurgy of the equilibrium diagrams. He thought that every neophyte should understand more of the equilibrium diagrams.

MR. E. R. WALTER asked Mr. Peace again to explain the austenite stages.

MR. PEACE said that if a metal which contained 1.7 per cent. of carbon was cooled sufficiently slowly, then when the temperature of 900 deg. C. was reached, the carbon content of that austenite would be just over 1 per cent., and the excess of carbon which it had rejected, according to the circumstances of cooling, would be either free graphite or it would be carbide. As the cooling was continued, 0.9 per cent. carbon was obtained, after which point there was a change in the structure to pearlite. With slow cooling nothing but pearlite was obtained.

MR. WALTER asked at what temperature the transformation to martensite and sorbite took place.

MR. PEACE said there was no definite formation temperature. The actual change took place at the temperature of about 730 deg. C., but the actual mechanism of the change of austenite to martensite was rather difficult to explain. The composition might be the same, but there was a change in structure. Restriction in cooling caused formation of martensitic and sorbitic structures, and this might be demonstrated by heating and quenching a cast iron.

MR. P. A. RUSSELL said that phosphorus had very little effect on strength of an iron that was initially weak, but where there was a fairly graphitic iron, then it had been demonstrated that the effect of phosphorus was very marked after the first 0.25 per cent. Mr. Peace had failed to emphasise that austenite was non-magnetic, and iron in the austenitic form was therefore really a different form of iron. There were two or three different types of iron which influenced the changes to austenite.

MR. PEACE said with regard to the effect of phosphorus on the strength of cast iron, that the phase he wished to emphasise was that some prejudice used to exist about the effect of sulphur, which was not always justified, and years ago is was considered that this element should not be present in cast iron. Similar notions existed as to phosphorus.

MR. R. H. BUCKLAND said that a large percentage of austenite in an iron had a softening effect. Mr. Peace had also mentioned that a graphite had a low density of approximately 2.5 and he asked if a test bar of fairly large diameter which was cast on end would have a larger amount of graphite higher up the bar than at the bottom.

MR. PEACE said Mr. Buckland was correct in saying that austenite was a soft structure. The structures of cast iron and cementite, etc., varied in strength and toughness. For example, cementite was hard and brittle, but irons containing an increasing amount of ferrite were softer and less brittle. The strongest substance was the sorbite, which was even stronger than pearlite.

In a test bar, when graphite was formed, before the metal solidified, and just after it was cast, it would actually move and float to the top. The movement was constricted because the metal was cooling down at the bottom. The majority of the graphite was formed just after the metal was solidified, and so the top of the bar would not have greater amount of graphite. It was due to the fact that graphite was not present in any quantity in the molten metal.

MR. W. T. EVANS appealed to the younger members to study the iron-carbon diagram. He would like the Paper to be given on a future occasion, when perhaps a little more explanation could be given regarding graphitisation.

MR. J. LUCAS asked what the phosphorus content should be when using nickel, and was the use of high phosphorus iron ruled out in such circumstances? He also asked if the proportion of manganese to sulphur, stated to be $1\frac{3}{4}$ to 1, was correct.

MR. PEACE thought that nickel should be used only with a medium phosphorus iron. The theoretical quantity of manganese to balance the effect of sulphur was 55 to 32, *i.e.*, $1\frac{3}{4}$ to 1, but in actual practice it had been found that the manganese should be appreciably higher than this, by 0.2 to 0.4 per cent.

MR. COCHRANE asked if the particles of graphite were all the same shape and size, and what effect they would have on the iron.

MR. PEACE said there was first a tiny particle, but if small pieces of solids were in the mould there was a tendency for the graphite to use them as starting points. If the cooling was very slow, those graphite particles joined up with other particles and made long flakes. If the cooling was very fast, it would not make these flakes. The formation of graphite certainly had a considerable effect on the properties of the metal, and he emphasised that this was largely due to the size of the flakes and the way in which the graphite was distributed. Finer graphite resulted in smaller flakes.

Vote of Thanks

MR. WALTER, proposing a vote of thanks, said much trouble could be saved by reference to an equilibrium diagram. MR. RUSSELL seconded the vote.

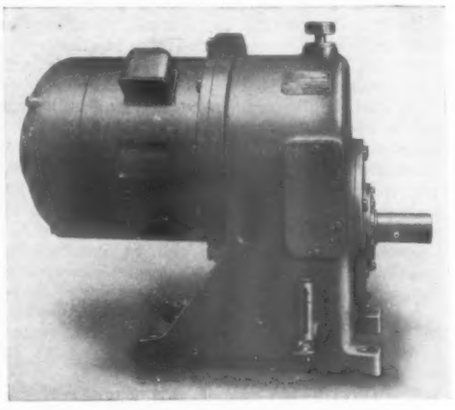
Testing Materials

In our last week's issue we published a list of Papers which will probably be given at the International Congress of the International Association for Testing Materials, which is to be held in London from April 19 to 24. Below we publish a further list of Papers, which in the main deal with light metals and their alloys and wear and machinability.

"Aluminium Alloys," by Dr. Steuzel; "Technology of Magnesium Alloys," by Dr. G. Siebel; "Recent Progress in Aluminium Casting Alloys," by Dr. A. G. C. Gwyer and H. G. Dyson, B.Sc.; "Recent Developments in Magnesium Alloys," by Dr. J. L. Haughton; "The Modification of Aluminium Alloys," by Prof. M. Gotô and Dr. S. Sugiura; "The Mechanism of Age-Hardening of Al-MgZn, Alloys," by Prof. M. Gotô and Sadajirô Kokubo; "The Evolution of Aluminium Alloys and Their Properties," by Prof. Dr.-Ing. A. v. Zeerleder; "Recent Progress in Aluminium Alloys in America," by E. N. Dix, jun., and Z. Jeffries; "Abrasion of Steels," by R. Grandmaître, Ing., A.I.M.S.; "Resistance to and Methods of Estimating the Abrasion of Steel," by F. Le Chatelier; "An Investigation of Abrasion in Cast Iron," by Dr. M. Suzuki; "Oxide Films as a Protection against Wear," by S. J. Rosenberg; "Workability," by Dr. M. Okochi; and "The Physical Attributes of Paint and Varnish Films," by Dr. L. A. Jordan.

New A.C. Geared Motor Unit

The great success of double-reduction geared motors during the past three years has proved conclusively the definite advantages of geared motors when designed and built as complete machines. For outputs of the order of 10 h.p., at 415 r.p.m. down to $2\frac{1}{2}$ h.p. at 145 r.p.m., a double-reduction gear box is seldom necessary. With this in mind the British Thomson-Houston Company, Limited, has now put forward a single-reduction box specifically to meet the demand for small units with a speed ratio not exceeding 5:1. The new units are at present designed for a.c. slip-ring or squirrel-cage machines up to 10 h.p. at $2\frac{1}{2}$:1 ratio, or 5 h.p. at 5:1 ratio. The same sturdy construction and accurately-generated helical gears which distinguished the double-reduction units is extended to the new range of single-reduction machines.



THE NEW A.C. SINGLE-REDUCTION GEARED MOTOR UNIT.

The gear efficiency is, however, slightly higher, being at least 99, irrespective of ratio. Three sizes of gear box are available.

The pinions are of nickel-chrome steel, whilst the gear wheels are cut from solid-forged special quality steel blanks. The manufacturing processes ensure an unusually high degree of accuracy combined with extreme durability. The gears are self-lubricating, the large wheel running in an oil bath, whilst special precautions are taken to prevent oil leakage along either high-speed or output shafts; the motor bearings are grease packed. The units, after being put to work, need no attention beyond adding a small quantity of oil from time to time to maintain the level necessary as indicated by the oil gauge.

Iron and Steel Production

The British Iron and Steel Federation reports that there were 114 furnaces in blast in the United Kingdom at the end of January, four more than at the end of December. The production of pig-iron in January amounted to 650,700 tons, compared with 671,400 tons in December, and 595,500 tons in January, 1936: the month's production included 164,600 tons of hematite, 342,800 tons of basic, 120,800 tons of foundry, and 11,000 tons of forge pig-iron.

The production of steel ingots and castings in January amounted to 998,900 tons, compared with 1,019,200 tons in December, and 912,500 tons in January, 1936.

PROPOSALS FOR A REDUCTION of the capital of the Millom & Askam Hematite Iron Company, Limited, from £2,000,000 to £683,321 were approved by Mr. Justice Eve in the Chancery Division on Monday.

STANTON-DALE
REFINED PIG IRON

Three typical analyses

	Total Carbon	Silicon	Sulphur	Phos.	Mang.
Motor-car cylinders	3	1·8-2·2	·05	·3	·5
Hydraulic Work	3·2	1·5-1·8	·07	·4	·5
Gas and Marine cylinders	3	1·3-1·6	·07	·5	·5

Stanton-Dale is a low total carbon pig giving close-grained, grey iron castings of great strength and toughness. Seven standard grades are available, and we can also supply to customers' own requirements without extra cost.

The Stanton Ironworks Company Limited, Near Nottingham

The Largest Producers of Foundry Pig Iron (for sale) in Great Britain

Mould and Core Drying Methods

At a recent meeting of the Scottish Branch of the Institute of British Foundrymen Mr. W. H. Smith read a Paper "Mould and Core Drying by Modern Methods," which was published in our last week's issue. The discussion which followed was opened by the CHAIRMAN (Mr. Frank Hudson), who said that the Paper had been most interesting and intensely practical. Mr. Smith had illustrated modern mass production core-shop methods particularly with regard to conditions in the Midlands. In Scotland, most of the work done was connected with the heavy industries and he, the speaker, thought there was room for attention to be given to the design of stoves for drying large dry-sand and loam work.

Analogy with Timber Drying

Whilst in America he had spent some time studying the problem of drying timber, and it would be appreciated that there was a very definite relation between drying timber and loam jobs. The successful drying of timber entailed control of the humidity inside the drying kiln according to the initial moisture content of the green wood and the moisture content at successive stages in the drying operation as gauged by test-pieces extracted from the kiln. As the moisture content of the wood fell, so the humidity of the drying atmosphere was reduced until only dry, hot air was admitted. Unless this practice was observed the wood warped and cracked badly and was unfit for future use.

An American Stove

A similar problem arose and was overcome in a like manner in the drying of many ceramic articles, but this practice had never, with one exception, been used by the founder. In regard to this exception reference should be made to the Transactions of the American Foundrymen's Association, Vol. 35, 1937, page 214 where a Paper, "A New Type of Mould Drying Oven" by S. H. Wright and J. M. Sampson, outlined a new type of stove developed in the steel foundry of the (American) General Electric Company, at their Schenectady works. Briefly, the stove was approximately 16 ft. wide, 30 ft. long, and 11½ ft. high inside, and was heated by hot air circulated through a nest of steam heating coils; provision was made for the control of humidity by incorporation of a live steam jet in the air stream. When the steam heat was first turned on and the blowers started, live steam was injected into the oven until the temperature of the centre of the moulds reached 180 deg. Fah. The time required for this varied from 2 to 4 hours. The humidity prevented the skin or surface of the mould drying and assured a steady flow of moisture from the interior of the mould to the surface by capillary attraction and gave complete prevention of surface cracks. Too often the foundrymen blamed sand and loam conditions when excessive surface cracking was obtained, when actually the trouble lay in the use of entirely wrong drying methods. Mr. Smith would perhaps take particular note of the American modification in the hope that at some time in the future he would design a stove more suited to drying sand and loam of high moisture content so essential to the heavy industries carried on in the Glasgow area.

MR. J. M. PRIMROSE said continuous stoves were very useful in large works with, say, many hundreds of cores to be dried, but most of the works in the Glasgow area were not large enough to keep stoves working. The carriers such as had been shown could do a large quantity of work, but difficulty was found with the elevated carrier, and in addition the rubber wheels burnt off. The best core shop he had seen was in Germany, where they used overhead beams for conveying cores to the stoves, and in addition a small track to take carriers in the stove. There was no jarring of the cores. The shop in question was small, but the arrangement could be enlarged.

MR. W. H. SMITH replied that in actual practice getting cores in and out of stoves did not present difficulties. The floor was normally the coolest part of the stoves, and the rubber tyred wheels were not in the stove long enough to get burned. An alternative method was to use frictionless bogies on rails, and lift the core racks on to the bogies by crane. As far as the monorail method of carrying racks into the stove was concerned, Mr. Smith had not seen the Continental stove referred to, but apparently it was very similar to that used by Sterling Metals, Limited, and replaced by the continuous system just over three years ago. The monorail system had two disadvantages, namely, objectionable fumes from the cores, and excessive heat in the shop in the summer months.

MR. N. MCMANUS, speaking with regard to the moisture in the stove, asked whether, by rapidly raising the temperature, damage such as Mr. Hudson had referred to was done. He also wished to know if the sand on the Redler conveyor which Mr. Smith had illustrated was in a dried or moist state.

MR. SMITH said that both Mr. Hudson and Mr. McManus were asking for absolutely automatic control where a certain amount of skill was at present required in operating the short period firing furnace. Moisture should be present throughout the early stages of drying, and this was retained by keeping the exhaust damper partly closed during most of the "forcing" period, opening it fully for 2 or 3 mins. to relieve the heavy pressure of steam generated as the stove approached maximum drying temperature, and then almost closing it again for the "soaking" period, so that the atmosphere within the stoves was dried gradually. To produce this result automatically might be possible, but one had to keep in mind that it must be done at an economic cost to find a market.

MR. J. MILLER said that fumes were absent in the continuous drying stove, and where formerly trouble was experienced because of excessive heat, complaints were made that the shop was too cold. In regard to conveyors for cores, the foundry with which he was connected was compelled, owing to the length of the shop, to adopt the roller type, but the core plates travelled quite easily, and no breakage took place with the cores. Deeper cores could be placed on to the trays of the drying stoves by removing the top one, and from 4,000 to 5,000 cores were stoved at a cost per day of 5s. His company intended to put in more of the continuous type of stoves shown by Mr. Smith.

MR. SMITH said he believed the conveyor referred to by Mr. Miller was made by the same firm as the one he had illustrated. It was not an ordinary one, but specially designed and guaranteed to carry green cores without vibration.

MR. A. MENZIES said that he had had trouble in Singapore with some cores being burned and others with the inside not dried. To overcome this he eliminated the firebox and replaced it by a pipe from an oil tank and compressed air. The moulds never became overheated and the cost was much reduced. The only trouble was that they burned out the floor of the stove.

MR. SMITH replied that by accident or design the burner opening into the stove must have been of correct proportion to accommodate the extra air. There was a vast difference between chimney draft and forced draft. If the "pull" of a chimney depended upon when the damper was opened, the hot gases went direct to the chimney. The value of forced draft depended on the control. In regard to a stove burning at floor level, this may be due to incorrect setting of the furnace, or to the chimney. It would not be possible to say definitely without seeing the stove. With oil firing good results were possible, but coke fuel was more economical.

Spelter's Wonderful Rise

BY "ONLOOKER."

Not many months ago spelter prospects were regarded with a good deal of gloom, and the metal had very few friends, either on or off the Metal Exchange. Demand was not too good, and production, running at a good round rate, was generally supposed to be outstripping consumption and leading to an increase in stocks throughout the world. Halfway through 1936 the London quotation was below £14, and as late as the end of October the price was still below £16, but the last two months saw a rapid change and at December 30 only a few pence kept spelter below £20. With minor setbacks, January saw a further steady advance, while in the early days of February this quickened so that at the present time forward spelter is valued at well over £23, with sentiment so favourable that a level of £27 in the near future is envisaged. There is a lot of speculative buying on the Exchange, but at around £24 there has been a good deal of quiet liquidation by operators, who can see a useful profit and are wise enough to make sure of it while the going is good. However, other speculators are coming in to take their place, and, moreover, consumers are buying, too.

How can one account for this really remarkable *volte face* in the fortunes of spelter? The speculator has come in for harsh criticism during the past few months, but in the matter of spelter he has certainly shown himself to be fairly astute, for a price appreciation of 50 per cent. in but little over three months could not have come merely as the result of speculation alone. Events have shown that spelter was ripe for a rise, and it now appears evident that consumers have been busy re-stocking after a longish period of abstention when hand to mouth purchasing seemed the only worth while course to pursue. This change of heart is something very fundamental that has taken place among users of non-ferrous metals, and, indeed, of all commodities, for, as everyone knows, the slump years saw the development of buying habits which relied on eleventh hour deliveries by the producers and cut down stock maintenance to a minimum. This idea has perforce been abandoned, for with a marked increase in the rate of spelter usage supplies at a minute's notice cannot be relied upon, and in many directions there are inquiries for delivery over the whole of the present year. This is perhaps rather overdoing it, for production is now distinctly on the upgrade, and will continue to increase as long as the price of the metal keeps above £20 per ton. Temporarily there certainly seems to be some scarcity, but this will pass in due course.

Reference has been made to the fact that the rate of consumption has increased, and this is so in the galvanising industry. The brass makers are also busier than they were, and their call for spelter has increased accordingly. Ever since an import duty was levied on foreign spelter in 1932 the consumers of the metal in this country have relied almost entirely upon Empire brands and home production, but during the past week or two a modest tonnage of foreign metal has been sold owing to the scarcity of duty-free brands and the high premiums demanded by sellers. On the Continent a big demand for high-grade zinc has developed, and buyers have paid high premiums for electrolytic brands rather than go short of an all-important raw material. No doubt this spasm will pass, but while it lasts spelter is going to be something of a luxury, and almost inevitably the London price will go higher. It may be some months in coming, but it would seem that spelter is once again going to recapture its position of price ascendancy over lead, which is gradually declining in value as spelter rises. To be short of spelter at the present juncture would certainly seem to be the height of folly.

MACHINE CAST PIG is UNIFORM in COMPOSITION

Workington Machine-Cast Pig Iron is more uniform in analysis because the iron from the blast furnaces is first poured into large ladles and thoroughly mixed before casting, instead of being run direct from the furnace on to sand beds.

Quicker melting and a saving in coke consumption are other advantages to the user.

THE UNITED STEEL COMPANIES LTD

WORKINGTON PIG IRONS ARE NOW ALL MACHINE-CAST

WORKINGTON IRON & STEEL COMPANY · WORKINGTON · CUMBERLAND

BRANCH OF THE UNITED STEEL COMPANIES LIMITED

W.32

The Week's News in Brief

Trade Talk

WILLIAM DOXFORD & SONS, LIMITED, Sunderland, are to build a 9,000-ton motor-vessel for a foreign firm.

ALLOY PRESSURE DIE PRODUCTS, LIMITED, die casters, of Bowker Street, Willenhall, Wolverhampton, have recently extended their premises.

ALL THE SEVENTEEN lorry drivers of R. & A. Main, Limited, Gothic Works, Edmonton, London, and Falkirk, have qualified for the "Safety First" award.

A. C. WICKMAN, LIMITED, Coventry, are now the sole agents in Great Britain and Ireland for the material testing and balancing machines made by Losenhausenwerk, Düsseldorf.

THE ROSE STREET FOUNDRY & ENGINEERING COMPANY, LIMITED, Inverness, have secured a contract from the London Passenger Transport Board for the supply of electrical welding machinery.

A LECTURE ON "THE BRASS FOUNDRY" was given by Mr. A. Crowther, of Peglers, Limited, Doncaster, to members of Peterborough Ironmongers' Assistants' Association at Peterborough on February 9.

RANSOMES & RAPIER, LIMITED, of Ipswich, have secured a £210,000 contract from the Egyptian Government for building the sluice-gates on the new Mohammad Aly Barrage on the Nile. The total cost of the barrage will be £2,250,000.

AN ORDER HAS BEEN RECEIVED by J. L. Thompson & Sons, Limited, shipbuilders, of Sunderland, for a 9,000-ton steamer for Wallem & Company, a British firm trading at Hong Kong. The engines will be built by George Clark, Limited, Sunderland.

SWAN, HUNTER & WIGHAM RICHARDSON, LIMITED, of Wallsend, have received an order for a 26,500-ton motor-ship from the Shaw, Savill & Albion Company, Limited, of London. The vessel will be the largest passenger liner to be built on the Tyne since the "Mauretania."

INTERNATIONAL COMBUSTION, LIMITED, exhibited a film of the works at their club in Derby recently. The film was entitled "Energy—A Record of Modern Engineering," and showed the different processes of manufacture from receipt of the order to the completed article.

ABBOTSHAUGH ENGINEERING COMPANY, LIMITED, wood-working machinery manufacturers, of Falkirk, have purchased the disused works of Chaplin & Company, Limited, in Helen Street, Govan. The plant at the company's Falkirk works is to be sold and the works offered for sale.

THE MIDLAND ELECTRIC MANUFACTURING COMPANY, LIMITED, have changed their address to M.E.M. Works, Reddings Lane, Birmingham, 11. At this new address a new works, including a foundry, is under construction, and production has already commenced in some sections.

WILLIAM DENNY & BROS., LIMITED, Dumbarton, are to build two 8,600-ton cargo vessels for the British & Burmese Steam Navigation Company, Limited. The propelling machinery, consisting of single-screw reciprocating engines, is to be built by Rankin & Blackmore, Limited, Greenock.

THE COMMERCIAL AND TECHNICAL DEPARTMENT of the Leicester City Libraries is engaged in building up a collection of manufacturers' catalogues, and firms are invited to supply a complete set of their current publications, which will be indexed in the card catalogue, both under the firm's name and the particular productions in which they specialise.

THE L.M.S. RAILWAY COMPANY have given notice of an appeal against the decision of the Traffic Commissioners for the South of Scotland Area granting the White Line Transport Company, of Falkirk, a public carriers' licence for five vehicles to carry light castings. The latter company's application for a licence was originally before the Traffic Commissioners at a sitting in Edinburgh in November last, and the decision of the Traffic Commissioners was reported in our issue of December 31.

BIRMINGHAM ELECTRIC FURNACES, LIMITED, have acquired, by an agreement with G. Siebert G.m.b.H., sole manufacturing and patent rights in the well-known Kaercher electrically-heated salt-baths for Great Britain and the British Empire, except Canada. These equipments are used for the heat-treatment of aluminium alloys, and employ easily replaceable internal heating elements of special design giving exceptional uniformity and rapidity of heating, long life and complete safety in operation.

THE GENERAL COMMITTEE of "Lloyd's Register of Shipping" offer a scholarship, valued £100 a year for three years, to be awarded on the results of the studentship examination of the Institute of Marine Engineers in June, 1937. The scholarship is intended to assist marine engineering students to take an advanced course of instruction in engineering subjects. The age limit is 18 to 23 years, and the closing date for entries is May 1. Full particulars, entrance forms and copies of previous papers may be obtained on application to the secretary, the Institute of Marine Engineers, 85, The Minories, London, E.C.3.

IN AN ADDRESS last Thursday to the Falkirk Rotary Club, Mr. J. M. Primrose, managing director of the Grangemouth Iron Company, Limited, Falkirk, pointed out that since the Carron Company produced the first coal grate, ironfounders in Scotland had made little improvement. Falkirk ironfounders, he said, had never studied the fundamental points in their search for the perfect grate, and consequently they now had competitors throughout the world. Mr. Primrose admitted, however, that the ironfounders in Falkirk had been studying this question more fully recently, and that shortly there would be a revolution in coal fires, so far as heating was concerned.

THE ANNUAL MEETING of the Combustion Appliance Makers' Association (Solid Fuel) is to be held on March 16, at the Connaught Rooms, London. Capt. Crookshank (Secretary for Mines) has accepted an invitation to attend the annual luncheon as principal guest. The General Council, at its quarterly meeting last week, approved arrangements for holding a conference on coal-burning appliances in conjunction with the annual meeting. The conference will be open by invitation to members of the coal industry and users of coal and coke. Papers will be presented for discussion dealing with applied combustion research, the domestic market for solid fuel, and the progress of mechanical firing. Any users of solid fuel desiring to attend the conference should apply for tickets to the secretary, Combustion Appliance Makers' Association (Solid Fuel), British Industries House, Marble Arch, W.1. Mr. J. A. Reavell, chairman of the Kestner Evaporator & Engineering Company, Limited, ex-President of the Institution of Chemical Engineers, has been elected to succeed Col. J. H. M. Greenly, deputy-chairman of Babcock & Wilcox, Limited, as President of the Association for 1937-38.

Obituary

MR. JAMES MAITLAND WEIR, foundry manager of Charles W. Taylor & Son, Limited, South Shields, has died, aged 72.

MR. JOHN FEARNSIDE, a director of Samuel Fearnside & Sons, Limited, ironfounders, Keighley, died on February 12, aged 71. Mr. Fearnside was a member of the Keighley Association of Engineers.

THE DEATH HAS OCCURRED of Mr. James Bolas, who for 51 years was associated with Nasmyth, Wilson & Company, Limited, engineers and ironfounders, of Patricroft. He retired in 1934, having held the position of works manager for 34 years.

New Company

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Russell Edwards & Company, Limited, Brownedge Road, Bamber Bridge, near Preston.—Capital, £100. Iron, steel, brass and bronze founders, etc. Directors: R. Edwards, J. Ashworth, and J. Blackburn.

Company Report

Delta Metal Company, Limited.—Dividend of 12½ per cent. and a bonus of 15 per cent., both free of tax, for 1936.

Personal

MR. S. G. SMITH has changed his address to 153, Sturdee Avenue, Gillingham, Kent.

THE GRANTHAM TOWN COUNCIL have decided to bestow the honorary freedom of the borough upon Mr. A. R. Bellamy, a director of Ruston & Hornsby, Limited, of Lincoln and Grantham.

MR. G. COOP AND MR. P. HEMINGWAY have been elected directors of Daniel Doncaster & Sons, Limited, Sheffield. Mr. Coop is chief engineer, and Mr. Hemingway work's superintendent.

MR. N. MCNICOLL, overseas representative for British Timken, Limited, Birmingham, left England on February 11, for a three months' tour of Italy, Egypt, the Near East and the Balkans.

THE WORKS MANAGEMENT ASSOCIATION has recently elected a number of important industrialists as the first members in their newly constituted grade of fellowship. In all cases the election is in recognition of their services to industry and to the Association. Amongst these are several names prominent in the foundry industry:—Rt. Hon. Lord Amulree, first President; Sir Valentine Crittall, chairman and managing director, Crittall Manufacturing Company, Limited; Mr. E. J. Fox, managing director, Stanton Ironworks Company, Limited; Mr. Frank Hodges, director, William Beardmore & Company, Limited; Mr. Sam Mavor, chairman, Mavor & Coulson, Limited; Mr. C. P. Newman, chairman and joint managing director, Newman, Hender & Company, Limited; Mr. Harry Winterton, chairman and managing director, W. Cumming & Company, Limited; and Mr. A. P. Young, manager, Rugby Works, British Thomson-Houston Company, Limited.

MR. WESLEY LAMBERT, C.B.E., a Past-President of the Institute of British Foundrymen, has been elected an honorary member of the Institute. Mr. Lambert is one of the best known non-ferrous metallurgists in this country, and for many years held the position of manager of the metallurgical department of J. Stone & Company, Limited, Deptford and Charlton. He received his early training at Roan School, Greenwich, and his technical training at King's College, where he received the Jelf Medal and the Cunningham Prize. In 1890 he was appointed assistant metallurgist at the Royal Gun Factories, Woolwich, and in 1894 the Ottoman Government employed him in the capacity of metallurgist and lecturer in engineering, chemistry and metallurgy. For these services he was decorated by H.I.M. the Sultan with the Order of the Medijidieh. Returning to England, Mr. Lambert was appointed chief metallurgist at the Royal Gun Factories, Woolwich. For several years he acted as a special lecturer to the Sir John Cass Technical Institute (University of London), and his connection therewith is commemorated by the gift of a medal bearing his name. Mr. Lambert was elected President of the Institute of British Foundrymen in 1929, and presided over the International Foundry Conference held in Great Britain in that year. He is also a Life Fellow of the Chemical Society, and was created Commander of the Order of the British Empire in January, 1931.

Forthcoming Events

Institute of British Foundrymen

FEBRUARY 20.

East Midlands Branch:—"Cupola Practice." Paper by D. McLain, of the U.S.A., to be presented by T. Spiers, at the College of Technology, Leicester, at 6 p.m.

Lancashire Branch:—"A Small Oil-fired Rotary Furnace and Its Products." Paper by E. W. Wynn, at the Engineers' Club, Albert Square, Manchester, at 4 p.m.

FEBRUARY 27.

East Midlands Branch:—Annual Dinner at Loughborough.

Lincolnshire Section:—"Steel Castings." Paper by F. Cousans, at the Technical College, Monks Road, Lincoln, at 7 p.m.

Newcastle-upon-Tyne Branch:—Paper by Victor Stobie, at Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

Wales and Monmouth Branch:—"Non-Ferrous Metals." Paper by C. A. Howe, and "Recommendations of the Non-Ferrous Sub-Committee for Two Leaded Gunmetals," at the Technical College, Newport, at 6.30 p.m.

The Institute of Vitreous Enamellers

FEBRUARY 25.

Scottish Section:—"Adherence of Enamel to Cast Iron." Paper by Dr. James White, of the Royal Technical College, Glasgow, at the Royal Technical College, Glasgow, at 7.30 p.m.

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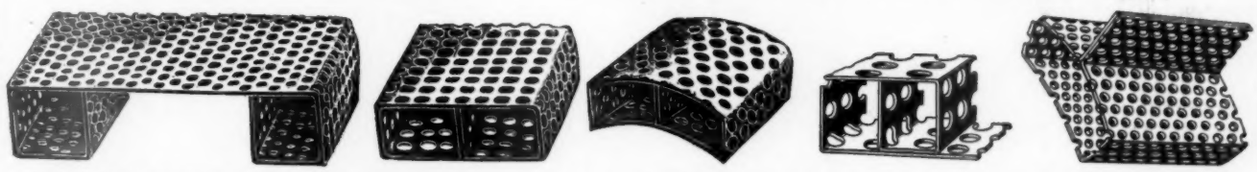
FOR EVERY BRANCH OF FOUNDRY INDUSTRIES

PERFORATED CHAPLETS. ALL SHAPES—SIZES—AND THICKNESSES



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SEND US YOUR ENQUIRIES.

WE CAN QUOTE YOU RIGHT.

LARGE QUANTITIES OF STANDARD SIZES STOCKED.

ALSO MAKERS OF

DOOR CATCHES, HINGE TUBES & DOVE TAILS FOR THE GENERAL STOVE & RANGE TRADES.

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TOP HAT CHAPLETS.

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& ETC.

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ESTABLISHED 1874

WARNER Special PIG IRONS

- Warner C.B.R. and
- Low Carbon Cylinder (FOR CYLINDERS, ROLLS, ENGINEERING CASTINGS, ETC.)
- Low Carbon Malleable (FOR MALLEABLE CASTINGS OF ALL DESCRIPTIONS)

Supplied to any specification between limits of 2·00 and 3·50% Carbon and ·50% and 3·50% Silicon

● ACTUAL ANALYSIS CERTIFICATES ARE AVAILABLE WITH EACH DELIVERY

● **Typical Cylinder Pig Iron Specification**

TOTAL CARBON	2·70%
SILICON	1·80%
MANGANESE	·90%
SULPHUR	·06%
PHOSPHORUS	·40%

● **Typical Malleable Pig Iron Specification**

TOTAL CARBON	2·60%
SILICON	·75%
MANGANESE	·50%
SULPHUR	·05%
PHOSPHORUS	·06%

WARNER & CO., LTD CARGO FLEET : MIDDLESBROUGH

Raw Material Markets

Consumers of iron and steel products continue to demand heavy deliveries against existing contracts, but producers are not in the position to increase their despatches, and it will be a considerable time before any substantial additional output is available. Only meagre tonnages can be despatched to customers overseas, but makers are endeavouring to maintain close contact with foreign markets. It is understood that the United States has received an inquiry from this country for the supply of 100,000 tons of pig-iron.

Pig-Iron

MIDDLESBROUGH.—There are many consumers in this area who are willing to pay higher prices than the existing minimum quotations to secure priority in supplies of pig-iron. Producers will not accept these offers, and any business which is done is at the official price levels, which are based on No. 3 Cleveland G.M.B. at 81s. per ton in the Middlesbrough area, 83s. elsewhere on the North-East Coast, 84s. in Falkirk, and 87s. on Clydeside. In the hematite market, also, the demand remains far in excess of the supply, and makers are compelled to announce that their order-books over the next few months are closed to new business. Makers have disposed of their production up to the end of June in most cases. East Coast mixed numbers are quoted at 97s. 6d. on the North-East Coast, 103s. in Sheffield, and 108s. 6d. in Birmingham, less 5s. per ton rebate where applicable.

LANCASHIRE.—While makers are willing to accept orders for replacement contracts, new business will not generally be entered into. Deliveries are behind schedule in many cases. For delivery to users in the Lancashire price zone, prices for Derbyshire and Staffordshire No. 3 foundry iron are on the basis of 89s. per ton, with Northamptonshire at 87s. 6d., and Derbyshire forge iron at from 84s. to 86s. West Coast hematite is quoted at 106s. per ton and East Coast material at 105s. 6d. Scottish foundry iron is at 105s., delivered equal to Manchester.

MIDLANDS.—The demand for all grades of pig-iron is very heavy. It is now impossible to obtain Northamptonshire material, and deliveries of this grade are restricted. Consumers of Derbyshire iron are entering into contracts and the supply of this grade is also running short. For delivery to Birmingham and Black Country stations, Northants No. 3 iron is quoted at 83s. 6d., with Derbyshire and Lincolnshire at 86s. Users of special-grade irons are placing orders for heavy tonnages. Frequently these irons are used as substitutes for hematite, which is in short supply. Refined iron is at the controlled minimum price of £6 17s. 6d. per ton. Medium-phosphorus iron is quoted at 92s. to 95s. and low-phosphorus from 97s. 6d. to 107s. 6d. Hematite makers will usually renew expired contracts, but the supply of iron available on the open market is very small. For delivery to Birmingham and Black Country stations the current prices are £5 9s. 6d. for West Coast mixed numbers, £5 8s. 6d. for East Coast No. 3, and £5 8s. for Welsh mixed numbers. An additional 1s. 6d. per ton is charged for delivery into works.

SCOTLAND.—Users of pig-iron in the Scottish area are demanding heavy deliveries, but the supply position is such that the tonnage available has to be carefully distributed. No. 1 foundry is quoted at 90s. 6d. and No. 3 foundry at 88s., f.o.t. furnaces. The lack of material is restricting activity among the light-castings makers. No. 3 Cleveland is quoted at 84s. f.o.t. Falkirk, and 87s. f.o.t. Glasgow. Northamptonshire foundry iron is quoted at 1s. 3d. per ton below Cleveland prices. Mixed numbers of hematite are quoted at 98s., less 5s. rebate, and basic, British and Indian, at 82s. 6d., less 5s. rebate, delivered steelworks in this area.

Coke

While most consumers of foundry coke considered that they had adequately covered their requirements over the winter months, many have found it essential to supplement these contracts with extra supplies. For delivery to Birmingham and district, best Durham coke is quoted at from 42s. 6d. to 45s., and Welsh coke at from 40s. to 54s. per ton.

Steel

The shortage which has characterised the steel market for several months past has reached a stage which is causing anxiety to all classes of consumers, says the official report of the London Iron and Steel Exchange. The production is still at a high rate, but is hampered by the difficulty of obtaining adequate supplies of raw material. For the time being it would appear that little relief can be expected from increased imports from the Continent. The Cartel steelmakers are much in arrears with deliveries against their quota, and, although a fresh release has been notified against the quota for the current three months, it is not anticipated that the steel will be available to users in this country for some time. The scarcity is particularly noticeable in the semi-finished steel department. The British producing works are reported to have sold their output for some months ahead and it is difficult to place fresh orders. The demand for finished steel, both on home and export account, shows no signs of relaxing. Business for oversea markets, however, is limited owing to the heavy pressure of the home demand. Nevertheless, the consuming industries are inconvenienced by delays in deliveries, in spite of the efforts which are being made to meet urgent needs.

Scrap

The increasing shortage of iron and steel scrap is causing considerable concern both to producers and consumers. From the Scottish area it is reported that a scheme of centralised buying of scrap may be introduced in the near future. Under this plan consuming districts would no longer be in competition with each other for either home or foreign scrap. Users of scrap in the Cleveland district are willing to pay much higher prices than the current recognised market quotations, but even at enhanced figures the acute shortage of supplies precludes the transaction of any substantial amount of business. For heavy cast iron 75s. is now being paid, while the price of heavy machinery has further advanced and is now quoted at from 77s. 6d. to 80s. Firm conditions continue to prevail on the South Wales market, but prices have remained steady. No price changes are reported from the Midlands, but a heavy demand exists, and, owing to the lack of tonnage, business is confined to small parcels for early delivery. The price of heavy steel on the Scottish market has advanced from 62s. 6d. to 67s., while wrought-iron piling is now quoted at from 77s. 6d. to 80s. The price of heavy machinery cast-iron scrap is firm at 82s. 6d. to 85s., for pieces not exceeding 1 cwt., while for ordinary cast iron, to the same specification, 75s. is being paid.

Metals

Agreement was reached in the United States labour dispute at the end of last week. As a result of the settlement it is hoped that industry in general will be able to settle down to a period of renewed activity and prosperity. In the United Kingdom, strength has been given to the non-ferrous metal market by the Chancellor's announcement that some £1,500,000,000 is to be spent on armaments over a period of five years. Prices in this country have been very firm.

Copper.—Speculative interest has again been accorded to this market and the position generally is firm. Heavy inquiries for forward business have been in circulation. Although consumption is at a high level, this does not wholly account for the present level of prices. Undoubtedly, the copper market, as also is the case with other metals, though to a lesser extent, is passing through a bull period, and little surprise would be occasioned were the quotation increased to £60 per ton in the near future. The price of copper in the United States has been raised from 13 to 14 cents per lb.

Daily market prices :—

Cash.—Thursday, £56 7s. 6d. to £56 8s. 9d.; Friday, £56 3s. 9d. to £56 5s.; Monday, £55 17s. 6d. to £55 18s. 9d.; Tuesday, £57 18s. 9d. to £58; Wednesday, £58 17s. 6d. to £58 18s. 9d.

Three Months.—Thursday, £56 11s. 3d. to £56 12s. 6d.; Friday, £56 7s. 6d. to £56 8s. 9d.; Monday, £55 18s. 9d. to £56; Tuesday, £57 18s. 9d. to £58; Wednesday, £58 18s. 9d. to £59.

Tin.—Prices became firmer on the news that the strike in the United States had been settled. Buying in this country has been on a moderate scale. Activity at the tinplate mills is being restricted by the acute shortage of steel. The Tin Investigation Committee has announced its decision that the Bolivian tin industry is capable of producing its full quota under the international agreement. The Committee urges some modification of the mining laws to facilitate development and the establishment of a special organisation to serve as a contact between the public authorities and the tin producers. The Committee indicates that Bolivia cannot regard tin control as being permanent, and that, in view of the high cost of production, Bolivia should investigate and use every means of developing low-cost production, and investigate and revise the freight rates now paid to the railroads for ore transportation.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £230 15s. to £231; Friday, £228 10s. to £228 15s.; Monday, £229 10s. to £229 15s.; Tuesday, £230 5s. to £230 15s.; Wednesday, £231 10s. to £231 15s.

Three Months.—Thursday, £231 15s. to £232; Friday, £229 10s. to £229 15s.; Monday, £230 10s. to £230 15s.; Tuesday, £231 5s. to £231 15s.; Wednesday, £232 10s. to £232 15s.

Spelter.—Recent heavy buying has been responsible for forcing prices up to the highest level since 1930. The market is well supported and the undertone is firm. It is generally accepted that the revival in the spelter market is of a permanent nature and not solely the result of its traditional sympathetic attitude to conditions prevailing in other markets.

Official quotations were as follow :—

Ordinary.—Thursday, £23 17s. 6d.; Friday, £23 15s.; Monday, £23 13s. 9d.; Tuesday, £24 8s. 9d.; Wednesday, £25 12s. 6d.

Lead.—Current production of lead is at a higher level than it was a month or so ago and supply and consumption are now more evenly balanced. World consumption of lead during 1936 is estimated at 1,616,500 metric tons, as compared with 1,450,700 tons in 1935.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £27 7s. 6d.; Friday, £26 18s. 9d.; Monday, £27; Tuesday, £27 7s. 6d.; Wednesday, £28 6s. 3d.

Price of Platinum.—The official quotation of platinum declined £1 to £13 per fine ounce on Monday, following a corresponding decline in New York. Although the fall was in the nature of a surprise, it was not altogether unwelcome, and the outlook for the metal is still considered to be excellent.

Foundry Wages

The National Union of Foundry Workers and the Iron Foundry Workers' Association have applied to the National Light Castings Federation for the restoration of the 5 per cent. cut imposed in 1927 on the wages of the men employed in the production of soil and rain-water castings. A joint committee of both sides has been set up to consider the application. The unions, representing the workers in the light-castings industry, have submitted a claim to the employers for an amended agreement to include an annual holiday with pay and adjustment of grievances connected with overtime, the night-shift and the three-shift system. This has been referred to a joint committee of five representatives from each side. Several thousand men are affected.

Patternmakers in the industry are to receive an increase of 2s. a week as from February 1 under an agreement negotiated by the United Patternmakers' Association, subject to a ballot vote of the members concerned. Under the proposed terms, the standard all-in rate for Scotland will be raised to 68s. 6d. a week, and for England to 66s. 6d. Where men are at present rated higher, there is to be no reduction, and where the higher rates are for special skill or responsibility, 2s. is to be added. Balloting on the terms is to be completed by the end of this month.

MR. E. W. WYNN has relinquished his position as foundry manager of the Audley Engineering Company, Limited, to set up business on his own account as an ironfounder. His new premises are situated at Watling Street, Cannock, Staffordshire. He is specialising in high-duty grey iron, alloy irons and pressure-resisting castings.

For **"easy stripping"** use

YORKSHIRE SAND

Yorkshire Sand is of a synthetic nature, its production being under careful laboratory control. Perfect standardization is obtained with the various grades, suitable for light and the heaviest steel castings.

It is because of the refractoriness of the sand and of the toughness of the mould surface that castings made with Yorkshire Sand are distinguishable by their excellent finish.

Please address all enquiries to the nearest Sales Office :

GENERAL REFRACTORIES LTD.,

Genefax House, Sheffield

Telephone :
Sheffield 31113 (6 lines).

Telegrams :
"Genefax, Sheffield."

LONDON OFFICE:	SCOTTISH OFFICE:	SOUTH WALES OFFICE:	MANCHESTER OFFICE:
Russell House, Adelphi, W.C.2.	156, St. Vincent St., Glasgow.	11, Wind St., Swansea.	9, Albert Square, Manchester, 2.
Telephone: Temple Bar 7361.	Telephone: 5250.	Telephone: 3680.	Telephone: Blackfriars 6130.
Telegrams: "Genefax, Rand-London."	Telegrams: "Genefax, Glasgow."	Telegrams: "Genefax, Swansea."	Telegrams: "Genefax, Manchester."

★

Read what an IMPORTANT STEELFOUNDER says :—

"During the 40 years I have been connected with Steel Foundry work, considerable changes have taken place. Away back, we had Steel Moulders' Composition, Old Crucible Pots, etc., and each works claimed to have its own 'secret' moulding composition. High Silica Sand has eliminated practically all these from many foundries and to-day we have your 'Yorkshire Sand' which acts almost like a chill, and leaves the skin of the casting blue-black and as clean as cast iron.

The hot steel lies quietly against the wall of sand, and often when the casting has been lifted out of the mould, the latter looks as if it could be used over again, just like a permanent mould."

RAW MATERIALS—PRICE LIST

(Wednesday, February 17, 1937)

COPPER

	£	s.	d.
Standard cash	58	17	6
Three months	58	18	9
Electrolytic	63	10	0
Tough	62	13	9
Best selected	63	3	9
Sheets	89	18	9
India	73	13	9
Wire bars	64	8	9
Ingot bars	64	3	9
H.C. wire rods	67	18	9
Off. av. cash, Jan.	51	10	10⅛
Do., 3 mths., Jan.	51	13	4⅞
Do., Sttlmnt., Jan.	51	10	6
Do., Electro, Jan.	56	13	0½
Do., B.S., Jan.	56	3	9
Do., wire bars, Jan.	57	0	4½

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 8⅞d.

BRASS

Solid drawn tubes 12d.
Brazed tubes 14d.
Rods, drawn 10½d.
Rods, extd. or rlld. 6½d.
Sheets to 10 w.g. 9⅞d.
Wire 9⅛d.
Rolled metal 9⅝d.
Yellow metal rods 6¼d.

TIN

	£	s.	d.
Standard cash	231	10	0
Three months	232	10	0
English	231	10	0
Bars	233	10	0
Straits	234	5	0
Australian		—	
Eastern	233	7	6
Banca	234	5	0
Off. av. cash, Jan.	229	9	10½
Do., 3 mths., Jan.	230	4	1½
Do., Sttlmt., Jan.	229	10	0

SPELTER

	£	s.	d.
Ordinary	25	12	6
Remelted	22	10	0
Hard	21	15	0
Electro 99.9	28	3	9
English	26	15	0
India	21	0	0
Zinc dust	26	10	0
Zinc ashes	7	10	0
Off. aver., Jan.	21	4	4½
Aver. spot, Jan.	21	3	0¾

LEAD

	£	s.	d.
Soft foreign ppt.	28	6	3
Empire	28	2	6
English	30	5	0
Off. aver., Jan.	27	4	2⅝
Aver. spot, Jan.	27	5	5¼

ALUMINIUM

Ingots £100 to £105
Wire 1/3 to 1/4 lb.
Sheet and foil 1/2 to 1/4 lb.

ZINC SHEETS, &c.

Zinc sheets, English	35	5	0	to 35	15	0
Do., V.M. ex-whse.	35	5	0	to 35	15	0
Rods				34	10	0

ANTIMONY

English	77	0	0	to 78	0	0
Chinese, ex-whse.				66	0	0
Crude, c.i.f.				36	0	0

QUICKSILVER

Quicksilver 14 3 0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—

25%				£	2	6
45/50%	10	15	0	to 12	0	0
75%	15	15	0	to 17	0	0

Ferro-vanadium—
35/50% 12/8 lb. Va

Ferro-molybdenum—
70/75% carbon-free 4/6 lb. Mo.
Ferro-titanium—
20/25% carbon-free 9d. lb.
Ferro-phosphorus, 20/25% £21 to £22
Ferro-tungsten—
80/85% 3/- lb.
Tungsten metal powder—
98/99% 3/1½ lb.
Ferro-chrome—

2/4% car.	31	17	6
4/6% car.	21	10	0
6/8% car.	21	0	0
8/10% car.	21	0	0

Ferro-chrome—

Max. 2% car.	32	10	0
Max. 1% car.	35	15	0
Max. 0.5% car.	36	10	0

70% carbon-free 9½d. lb.
Nickel—99.5/100% £180 to £185
"F" nickel shot £165 0 0
Ferro-cobalt, 98/99% 7/3 lb.
Metallic chromium—
96/98% 2/5 lb.
Ferro-manganese—

76/80% loose	£11	15	0	to 12	5	0
76/80% packed	£12	15	0	to 13	5	0
76/80% export			£10	15	0	

Metallic manganese—
94/96% carbon-free 1/3 lb.
Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.
Extras—
Rounds and squares, 3 in. and over 4d. lb.
Rounds and squares, under ½ in. to ¼ in. 3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in. 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in. 3d. lb.
Do., under ¼ in. × ¼ in. 1/- lb.
Bevels of approved sizes and sections 6d. lb.
Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel				3	10	0
Mixed iron and steel				3	7	6
Heavy cast iron	3	7	6	to 3	10	0
Good machinery				4	5	0
Cleveland—						
Heavy steel				3	5	0
Steel turnings				2	5	0
Heavy cast iron				3	15	0
Heavy machinery	3	17	6	to 4	0	0
Midlands—						
Short heavy steel				3	10	0
Light cast-iron scrap	2	15	0	to 2	17	6
Heavy wrought iron				3	10	0
Steel turnings				2	2	6
Scotland—						
Heavy steel				3	7	0
Ordinary cast iron				3	15	0
Engineers' turnings				2	8	9
Cast-iron borings				2	2	6
Wrot-iron piling	3	17	6	to 4	0	0
Heavy machinery	4	2	6	to 4	5	0

London—Merchants' buying prices, delivered yard.

Copper (clean)	47	0	0
Brass	27	0	0
Lead (less usual draft)	24	0	0
Tea lead	20	0	0
Zinc	14	0	0
New aluminium cuttings	74	0	0
Braziery copper	44	0	0
Gunmetal	45	0	0
Hollow pewter	170	0	0
Shaped black pewter	124	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—

Foundry No. 1	83/6
,, No. 3	81/-
,, No. 4	80/-
Forge No. 4	80/-
Hematite No. 1	98/-*
Hematite M/Nos.	97/6*

N.W. Coast—

Hem. M/Nos. d/d Glas.	98/-*
,, d/d Birm.	109/6*
Malleable iron d/d Birm.	135/-

Midlands (d/d Birmingham dist.)—

Staffs No. 4 forge	83/-
,, No. 3 fdry.	86/-
Northants forge	80/6
,, fdry. No. 3	83/6
,, fdry. No. 1	86/6
Derbyshire forge	83/-
,, fdry. No. 3	86/-
,, fdry. No. 1	89/-

Scotland—

Foundry, No. 1, f.o.t.	90/6
,, No. 3, f.o.t.	88/-
Cleveland No. 3, Glasgow	87/-
,, Falkirk	84/-
Scottish hem. M/Nos. d/d	98/-*

Sheffield (d/d district)—

Derby forge	80/6
,, fdry. No. 3	83/6
Lincs forge	80/6
,, fdry. No. 3	83/6
W.C. hematite	103/6*

Lancashire (d/d eq. Man.)—

Derby fdry. No. 3	89/-
Staffs fdry. No. 3	89/-
Northants fdry. No. 3	87/6
Cleveland fdry. No. 3	89/-
Glengarnock, No. 3	105/-
Clyde, No. 3	105/-
Monkland, No. 3	105/-
Summerlee, No. 3	105/-
Eglinton, No. 3	105/-
Gartsherrie, No. 3	105/-
Shotts, No. 3	105/-

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)				10	10	0
Nut and bolt iron	8	17	6	to 9	7	6
Hoops			11	7	6	and up.
Marked bars (Staffs) f.o.t.				13	0	0
Gas strip			11	7	6	and up.
Bolts and nuts, ¾ in. × 4 in.				16	10	0 and up.
Steel—						
Plates, ship, etc.	9	10	6	to 9	13	0
Boiler plts	10	0	6	to 10	3	0
Chequer plts.				11	3	0
Angles				9	3	0
Tees				10	3	0
Joists				9	3	0
Rounds and squares, 3 in. to 5½ in.				10	3	0
Rounds under 3 in. to ⅜ in. (Untested)				9	10	0
Flats—8 in. wide and over				9	8	0
,, under 8 in. and over 5 in.				9	13	0
Rails, heavy	8	5	0	to 8	10	0
Fishplates				12	10	0
Hoops (Staffs)				10	5	0
Black sheets, 24g. (4-t. lots)				12	0	0
Galv. cor. shts. (,,)				14	0	0
Galv. flat shts. (,,)				14	10	0
Galv. fencing wire, 8g. plain				15	10	0
Billets, soft				6	5	0
Sheet bars	6	2	6	to 6	10	0
Tin bars	6	2	6	to 6	10	0

PHOSPHOR BRONZE

Per lb. basis

Strip	12½d.
Sheet to 10 w.g.	13½d.
Wire	14½d.
Rods	14½d.
Tubes	16½d.
Castings	14d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

Per lb.

Ingots for raising	8d. to 1/2
Rolled—	
To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2½ to 1/8½
To 15 in. wide	1/2½ to 1/8½
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	8d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round—	
to 10g.	1/5½ to 2/0½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/4½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	22.76
No. 2 foundry, Valley	21.00
No. 2 foundry, Birm.	17.38
Basic, Valley	20.50
Malleable, Valley	21.00
Grey forge, Valley	20.50
Ferro-mang. 80%, seaboard	80.00
O.-h. rails, h'y, at mill	39.00
Billets	34.00
Sheet bars	34.00
Wire rods	43.00
	Cents.
Iron bars, Chicago	2.15
Steel bars	2.20
Tank plates	2.05
Beams, etc.	1.90
Skelp, grooved steel	1.80
Steel hoops	1.95
Sheets, black, No. 24	2.80
Sheets, galv., No. 24	3.40
Wire nails	2.25
Plain wire	2.60
Barbed wire, galv.	2.75
Tinplates, 100-lb box	$4.85

COKE (at ovens)

Welsh foundry	30/- to 32/6
,, furnace	24/6 to 25/6
Durham foundry	26/6
,, furnace	24/6
Scotland, foundry	28/-
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14	per box	19/9 to 20/3
,,	28×20	,,	39/6 to 40/-
,,	20×10	,,	28/- to 28/3
,,	18¾×14	,,	20/6 to 21/-
C.W.	20×14	,,	17/- to 17/3
,,	28×20	,,	35/6 to 35/9
,,	20×10	,,	23/9 to 24/-
,,	18¾×14	,,	17/3 to 17/6

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£8	10	0	to £9	10	0
Bars-hammered, basis	£17	0	0	to £18	0	0
Bars and nail-rods, rolled, basis	£17	0	0	to £18	0	0
Blooms	£13	0	0	to £14	0	0
Keg steel	£26	0	0	to £29	0	0
Faggot steel	£18	0	0	to £23	0	0
Bars and rods dead soft, st'l	£11	0	0	to £12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

			£	s.	d.		
Feb.	11	..	56	7	6	inc.	11/3
,,	12	..	56	3	9	dec.	3/9
,,	15	..	55	17	6	,,	6/3
,,	16	..	57	18	9	inc	41/3
,,	17	..	58	17	6	,,	18/9

Electrolytic Copper

			£	s.	d.		
Feb.	11	..	61	5	0	inc.	15/-
,,	12	..	61	0	0	dec.	5/-
,,	15	..	61	0	0	No	change
,,	16	..	62	10	0	inc.	30/-
,,	17	..	63	10	0	,,	20/-

Standard Tin (cash)

			£	s.	d.		
Feb.	11	..	230	15	0	inc.	90/-
,,	12	..	228	10	0	dec.	45/-
,,	15	..	229	10	0	inc.	20/-
,,	16	..	230	5	0	,,	15/-
,,	17	..	231	10	0	,,	25/-

Tin (English ingots)

			£	s.	d.		
Feb.	11	..	230	15	0	inc.	90/-
,,	12	..	228	15	0	dec.	40/-
,,	15	..	229	10	0	inc.	15/-
,,	16	..	230	5	0	,,	15/-
,,	17	..	231	10	0	,,	25/-

Spelter (ordinary)

			£	s.	d.		
Feb.	11	..	23	17	6	inc.	12/6
,,	12	..	23	15	0	dec.	2/6
,,	15	..	23	13	9	,,	1/3
,,	16	..	24	8	9	inc.	15/-
,,	17	..	25	12	6	,,	23/9

Spelter (Electro, 99.9 per cent.)

			£	s.	d.		
Feb.	11	..	25	17	6	inc.	12/6
,,	12	..	25	16	3	dec.	1/3
,,	15	..	26	6	3	inc.	10/-
,,	16	..	27	0	0	,,	13/9
,,	17	..	28	3	9	,,	23/9

Lead (soft foreign, prompt)

			£	s.	d.		
Feb.	11	..	27	7	6	inc.	7/6
,,	12	..	26	18	9	dec.	8/9
,,	15	..	27	0	0	inc.	1/3
,,	16	..	27	7	6	,,	7/6
,,	17	..	28	6	3	,,	18/9

Lead (English)

			£	s.	d.		
Feb.	11	..	29	10	0	inc.	10/-
,,	12	..	29	0	0	dec.	10/-
,,	15	..	29	0	0	No	change
,,	16	..	29	5	0	inc.	5/-
,,	17	..	30	5	0	,,	20/-

Imports and Exports of Pig-Iron, Castings, etc., in January, 1937, compared with January, 1935 and 1936

	January, 1935.	January, 1936.	January, 1937.	January, 1935.	January, 1936.	January, 1937.
Imports.	Tons.	Tons.	Tons.	£	£	£
Pig-iron—from British India	5,067	4,263	11,596	14,946	12,962	37,223
,, Foreign Countries	2,361	2,443	2,960	14,680	12,238	18,400
Total	7,428	6,706	14,556	29,626	25,200	55,623
Castings and forgings	308	566	473	7,847	19,266	11,297
Cast pipes and fittings	59	93	161	2,995	2,190	3,093
Stoves, grates, etc.	90	45	88	6,173	5,004	4,857
Baths	446	673	656	12,534	16,332	15,490
Hollow-ware, all kinds	177	303	306	10,508	15,977	17,674
Exports.						
Pig-iron, forge and foundry	6,347	4,128	8,073	22,066	15,900	34,797
,, acid	4,878	2,584	4,969	15,547	8,729	21,578
,, basic	—	28	—	—	112	—
Total	11,225	6,740	13,042	37,613	24,741	56,375
Castings and forgings	5,401	4,637	4,226	47,875	44,795	39,611
Cast pipes and fittings, up to 6 in. diameter	4,787	4,372	3,793	51,745	48,420	43,352
,, ,, ,, ,, over 6 in.	3,738	4,508	2,494	26,630	42,554	19,920
Stoves, grates, etc.	797	887	910	38,338	44,884	47,209
Sanitary cisterns	316	246	294	8,520	7,789	9,297
Bedsteads, including tubes therefor	341	402	419	12,783	15,217	15,842
Cast hollow-ware	303	409	374	12,020	14,435	13,280

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